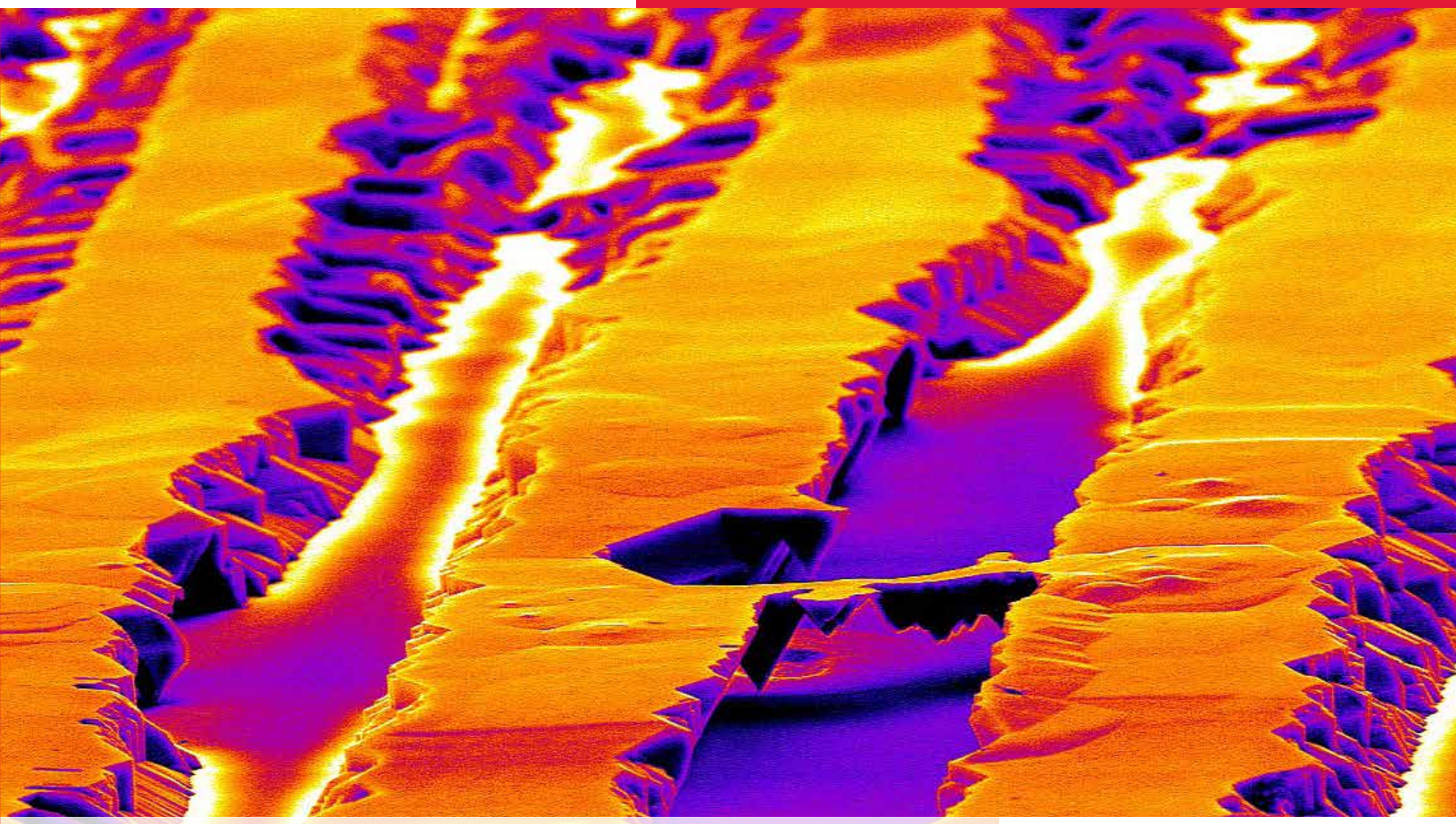
MSE NEWS

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

COLLEGE OF ENGINEERING
NC STATE UNIVERSITY | FALL 2016



NC STATE
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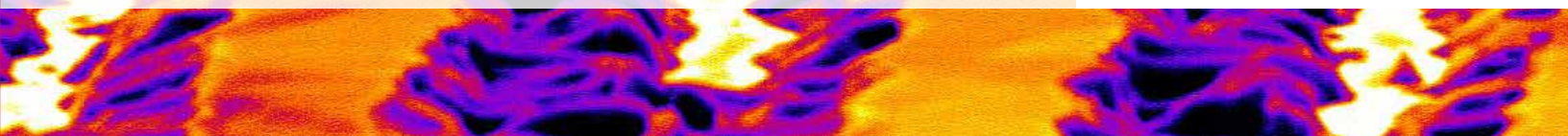

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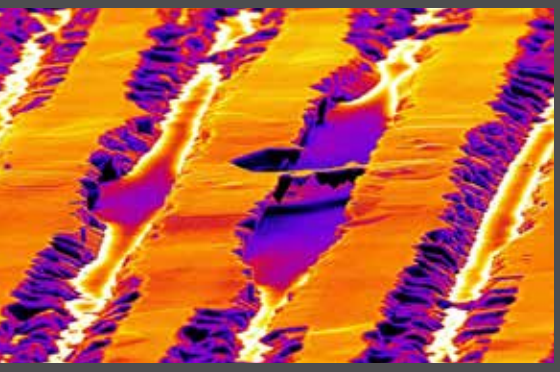
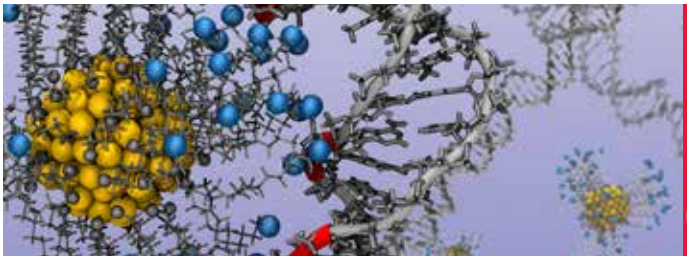


ABOUT THE COVER

MSE research scholar Felix Kaess won second place in NC State's first-ever research image contest with this image, Bridge Over Sapphire River. It is a false-colored field emission SEM image of an etched gallium nitride thin film structure that was grown on a crystalline sapphire wafer. See other striking images from the department's work on page 29.



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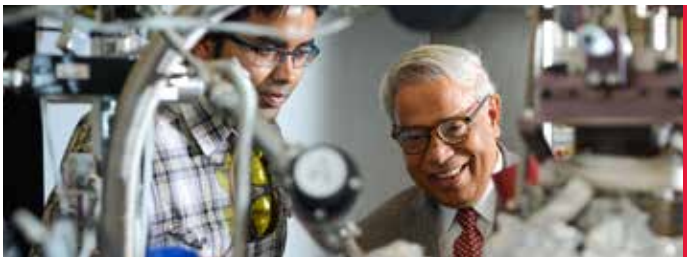

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A MESSAGE FROM **THE DEPARTMENT HEAD**

Dear MSE Friends and Stakeholders,

I hope you'll enjoy the fall 2016 newsletter, which highlights our continued upward trajectory as a premier Department of Materials Science and Engineering in the United States and the world.

Since the 2010-11 academic year, we have added 13 new faculty members, and while none started during the current academic year, Dr. Victoria Miller will join us as an assistant professor in fall 2017. Dr. Miller recently completed her Ph.D. at the University of California Santa Barbara, and is spending this year at the Air Force Research Laboratory. Dr. Miller is an expert in light metals, and her addition reinforces our long-term commitment to being a leader in metallurgy research. Our excellence in metallurgy was recognized recently by ATI, which selected us as one of three "partner schools." This is a new approach to university partnership by ATI, and will facilitate us building a deeper relationship with them, including senior design, student recruitment and research. We are proud to have been selected, and appreciate this tangible evidence of our departmental strength.

With the department expanding into new research areas, the search is on to recruit two additional faculty members. Thanks to the existing breadth and depth in the department, this search is not targeted at one or two particular research areas, but is instead a truly "open" search; we are simply seeking the two best materials scientists in the world.

In fiscal year 2015-16, MSE has shattered its own all-time records for new federal research contracts and grants, and in federal research expenditures. Already this year we are on track to surpass last year's records. Stay tuned for exciting updates!

Since our last newsletter, we have had an increase in visibility that is seen in the department's graduate program moving from 18th to 15th in *U.S. News & World Report* rankings and similarly our undergraduate program moved up to 16th. We have also successfully completed both a formal graduate program review in December, 2015, and our ABET site visit in September, 2016. I foresee both of our rankings moving up further as we experience continued growth in both the quantity and quality of our graduate students.

Achievements like the ones above are not possible except for faculty, students, alumni and friends like you who support our work unwaveringly. We appreciate your interest in our department and look forward to continuing our relationship with you.

Justin Schwartz
Kobe Steel Distinguished Professor
MSE Department Head

Since our last newsletter, we have had an increase in visibility that is seen in the department's graduate program moving from 18th to 15th in *US News & World Report* rankings and similarly our undergraduate program moved up to 16th.

Growth in research awards driven by department's excellence

The Department of Materials Science and Engineering has seen its annual research awards nearly triple over a ten-year period, from $4.7 million in 2005-06 to $13.4 million in 2015-16.

That steady growth has been capped off with a large jump during the 2015-16 fiscal year and the first few months of the 2016-17 year.

Awards more than doubled from $6.1 million in 2014-15 to $13.4 million in 2015-16. And that big trend looks to continue this year. Awards of $4.4 million through the first three months of 2016-17 is nearly equal to the awards for the entire 2005-06 fiscal year.

Department Head Dr. Justin Schwartz says the department has gotten much better at competing for and landing some of the largest research awards available in the field.

Schwartz points to the fact that the department is growing its faculty and every faculty member is research active. And many of those faculty members are skilled at working collaboratively, which is necessary to land large awards.

"The national movement has been more and more toward collaborative types of bigger funding over the last 10 years and we have really been responsive and ahead of the curve on that," he said.

The department has landed large research awards in taking the leading role in the Research Triangle Nanotechnology Network and the Center for Dielectrics and Piezoelectrics, as well as two multidisciplinary university research initiatives – one led by Dr. Jon-Paul Maria studying multi-modal energy flow at atomically engineered interfaces and one led by Dr. Donald Brenner studying entropy-stabilized alloys that can withstand extremely high temperatures.

The National Science Foundation and Department of Defense are the two major sources of the department's research funding. MSE is also active with the Department of Energy and that agency is becoming more of a funding focus.

Schwartz said that many of the important things that an engineering department does, from graduate research and education to research publications and the intellectual property that leads to startup companies, comes from research funding.

Making those things happen depends on great ideas and the funding to pursue them. The department has benefited in recent years from investments by the university and College of Engineering in research equipment and intellectual infrastructure in the form of faculty members. MSE has made good use of those investments.

"Not all great ideas get funding to pursue them if they don't have the right pieces to go with them," Schwartz said.

Researchers can tune mechanical properties of radiation-sensitive material for biomedical use

An interdisciplinary team of researchers at NC State has developed a composite material that emits light and heat when exposed to specific wavelengths of radiation and that can be customized to have specific mechanical characteristics. The composite holds promise for use in biomedical imaging, drug delivery and therapeutic treatments.

"The radiosensitivity is what makes the material useful for biomedical applications, and the ability to tune the mechanical properties makes it less likely to be rejected by the surrounding tissue in the body," says Nora Berg, an MSE Ph.D. student and lead author of a paper describing the work.

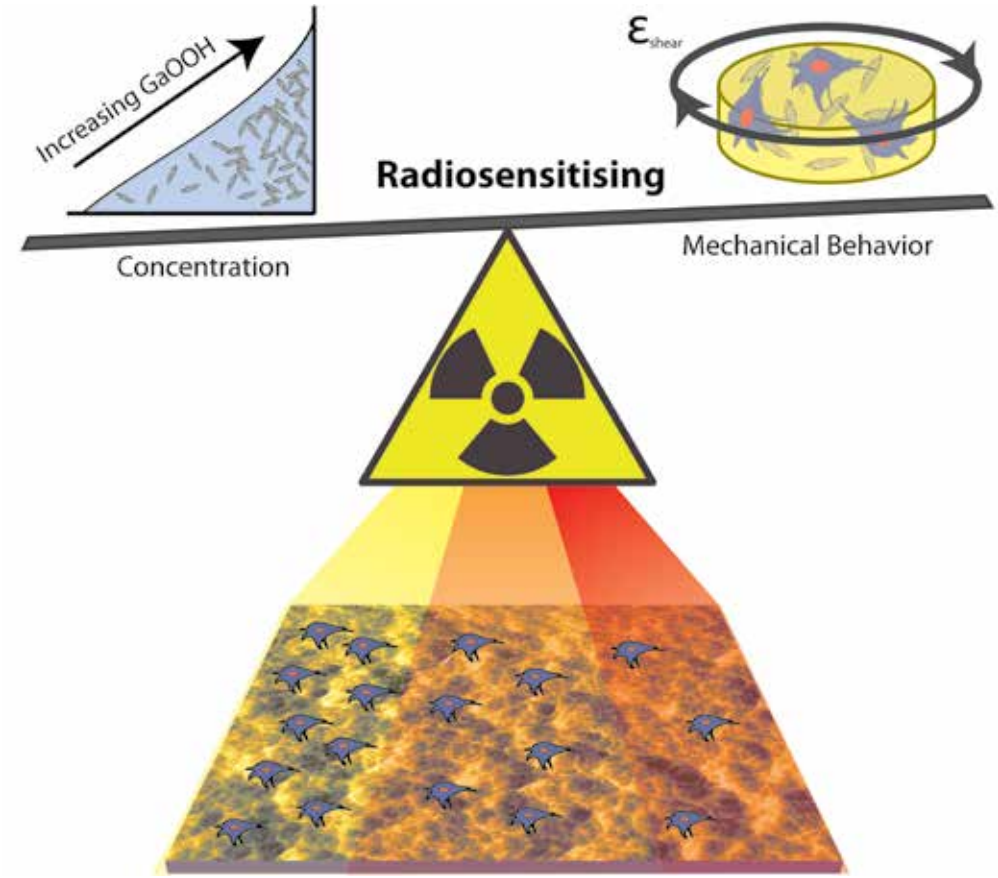
The material is a composite of a biological gel made of proteins and gallium oxyhydroxide (GaOOH), which is a semiconductor material. Specifically, the GaOOH is dispersed in the biological gel in the form of crystals that are 200-300 nanometers in diameter and approximately one micron - or micrometer - in length.

"When the composite is exposed to wavelengths of radiation that would be used in clinical settings, the GaOOH responds by heating up and emitting light," Berg says.

"This response to radiation makes it attractive for use in some therapeutic applications," says Albena Ivanisevic, corresponding author of the paper and a professor in MSE. "The radiosensitive response can help generate reactive oxygen species - like peroxide - that can be used to kill cells. So, this material may have value for targeting localized cancer sites."

The mechanical properties of the composite can be tuned by adjusting the concentration of GaOOH; adjusting the amount of GaOOH changes the structure of the gel, which affects the gel's stiffness. The mechanical properties were investigated in collaboration with Saad Khan's research group in NC State's Department of Chemical and Biomolecular Engineering.

To determine how the composite may interact with cells, the researchers did a proof-of-concept study. First, the researchers grew mouse-derived connective tissue cells - called fibroblasts - on the surface of composite samples. They then worked with researchers in NC State's College of Veterinary Medicine to expose the cell-covered samples to different amounts of clinically-relevant radiation.



The researchers found that higher doses of radiation increased cell death - but so did higher concentrations of GaOOH.

"This means that you can increase the concentration of GaOOH in the composite to cause cell death at targeted sites, while using less radiation," Ivanisevic says.

The researchers now plan to evaluate how the composite works with other cell types, such as neuronal cells, that are more resistant to radiation.

"The composite is relatively inexpensive and easy to make, and could be scaled up," Ivanisevic says. "It's important to note that, while this has practical applications, it is fundamental work - we are still in the in vitro testing stage. A lot of work lies ahead before this will be viable for clinical use."

Research on improved detection of light in mid-infrared range is part of spin-off company, Army research project

Professor Jon-Paul Maria

Research in the department that could lead to a better sensor to respond to light in the mid-infrared range is part of a spin-off company and a U.S. Army Multidisciplinary University Research Initiative.

Dr. Jon-Paul Maria, professor in the department, and his colleagues Dr. Edward Sachet and Dr. Christopher Shelton have enhanced the conductivity of cadmium oxide by "doping" it with a rare earth element called dysprosium. Cadmium oxide is one of a small number of materials that are transparent to a large spectrum of electromagnetic radiation but are also conductive. The research team increased that conductivity by nearly a factor of four, more than had ever been achieved previously.

In talking with colleagues, the team realized that their new material performs efficiently in response to light in the mid-infrared range (i.e., between 1,500 and 4,000 wavenumbers). That made it particularly useful for applications in infrared technologies.

"We were originally thinking about using this material for a biosensor," Maria said. "We realized it would be much more interesting as a material for infrared optics and sensors."

Drs. Sachet and Shelton, who were previous members of the MSE research group led by Maria, formed a spin-off company called Third Floor Materials with Maria.

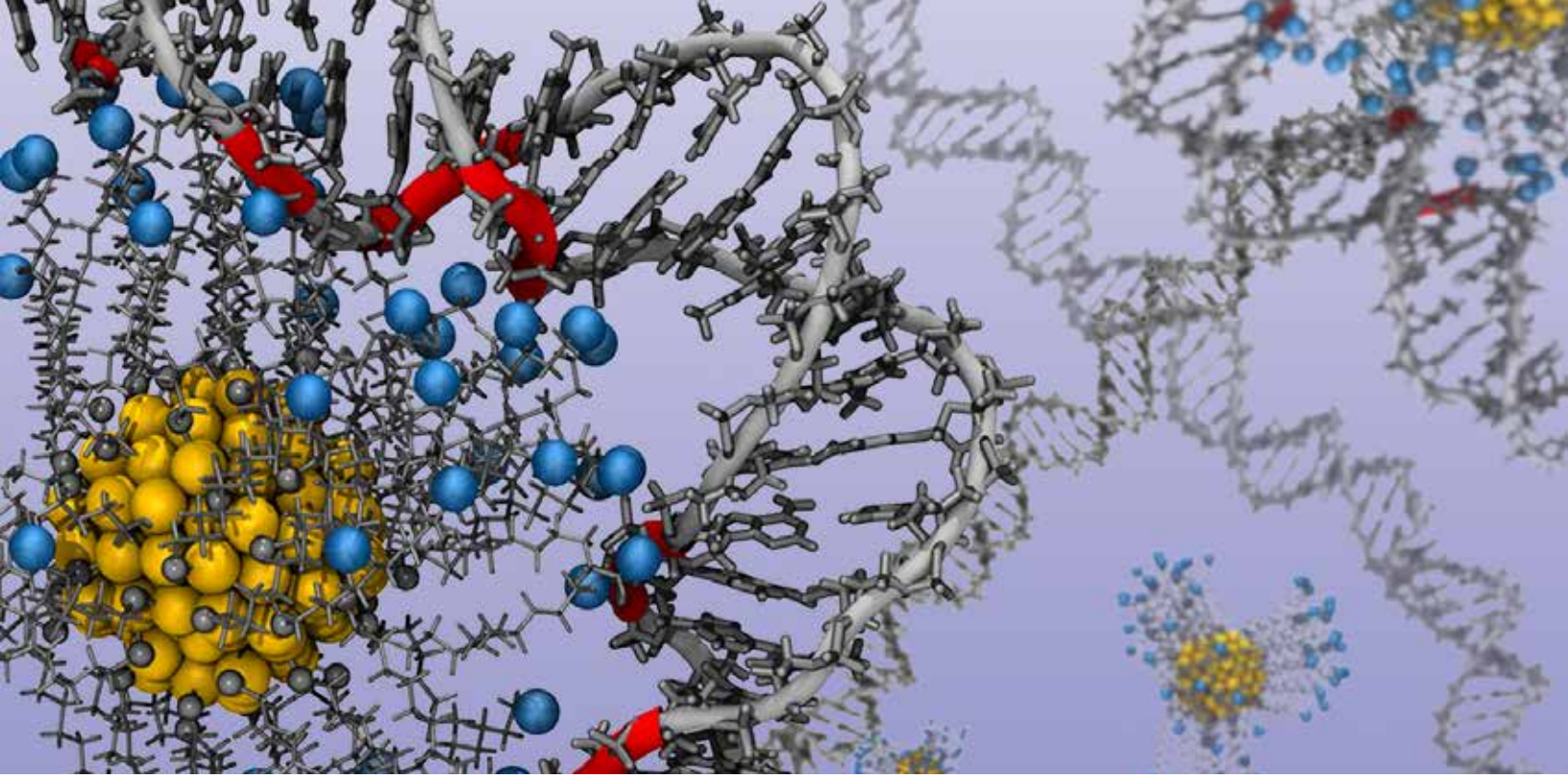
Current technologies used to detect in the mid-infrared range must be kept cooled to the temperature of liquid nitrogen (to ensure that the device itself doesn't produce the kind of radiation that it is trying to detect, skewing its readings). Devices made with this new cadmium oxide material would not need to be cooled and have the potential to be cheaper, easier to mass produce and lower in volume and mass.

The company has support from the NC State Chancellor's Innovation Fund along with NASA and DARPA. While NASA is interested in improved gathering of light readings in the mid-IR range with its satellites, DARPA would use the technology to enhance the capabilities and the safety of the US armed forces.

"All branches of the armed service would love to have multiple inexpensive midwave sensors on every vehicle," Maria said. "They would love to have every soldier equipped with an IR scope."

The material is also a part of a MURI awarded by the Army Research Office earlier this year. Maria is the principle investigator of the five-year program, which, along with NC State, includes the University of Virginia, the University of Illinois at Urbana and the University of Southern California.

The goal is to study how energy (in the form of both mechanical and electrical fields) is transduced across interfaces in extreme conditions on short time scales. Insights gained could inform the production of advanced munitions that minimize chances of an accidental detonation. While MURI goals are inspired by military needs, they are first and foremost fundamental research activities with the primary goal to educate new students and to discover and publish transformational science. The MURI team will explore these phenomena by: exposing tailored interfaces of nanoenergetic materials (i.e., thermite prepared from nanometer layers of Fe metal and Al2O3) to supersonic flyer plates (micron-size aluminum projectiles) and capturing the light, heat, and electrons that are emitted; and exposing extreme-high-mobility conductors like CdO to ultra-intense laser pulses, then watching the pathways by which that energy decays to heat. Because cadmium oxide is a good optical absorber, it's a convenient medium to create, manipulate and study those "hot" electrons that have absorbed energy.



Researchers detail how to control shape, structure of DNA and RNA

Researchers in MSE have used computational modelling to shed light on precisely how charged gold nanoparticles influence the structure of DNA and RNA - which may lead to new techniques for manipulating these genetic materials.

The work holds promise for developing applications that can store and transport genetic information, create custom scaffolds for bioelectronics and create new drug delivery technologies.

"In nature, meters of DNA are packed tightly into every living cell," says Jessica Nash, an MSE Ph.D. student and lead author of a paper on the work. "This is possible because the DNA is wrapped tightly around a positively charged protein called a histone. We'd like to be able to shape DNA using a similar approach that replaces the histone with a charged gold nanoparticle. So we used computational techniques to determine exactly how different charges influence the curvature of nucleic acids - DNA and RNA."

In their model, the researchers manipulated the charge of the gold nanoparticles by adding or removing positively charged ligands - organic molecules attached to the surface of the nanoparticle. This allowed them to determine how the nucleic acid responded to each level of charge.

"This will let researchers know what to expect - how much charge they need in order to get the desired curvature in the nucleic acid," says Yaroslava Yingling, an associate professor of materials science and engineering and corresponding author of the paper.

"We used ligands in the model, but there are other ways to manipulate the charge of the nanoparticles," says Abhishek Singh, a postdoctoral researcher at NC State and co-author of the paper. "For example, if the nanoparticles and nucleic acid are in solution, you can change the charge by changing the pH of the solution."

The work is also significant because it highlights how far computational research has come in materials science.

"Our large-scale models account for every atom involved in the process," says Nan Li, an MSE Ph.D. student and co-author of the paper. "This is an example of how we can use advanced computational hardware, such as the GPUs - or graphics processing units - developed for use in videogames, to conduct state-of-the-art scientific simulations."

The research team is now building on these findings to design new nanoparticles with different shapes and surface chemistries to get even more control over the shape and structure of nucleic acids.

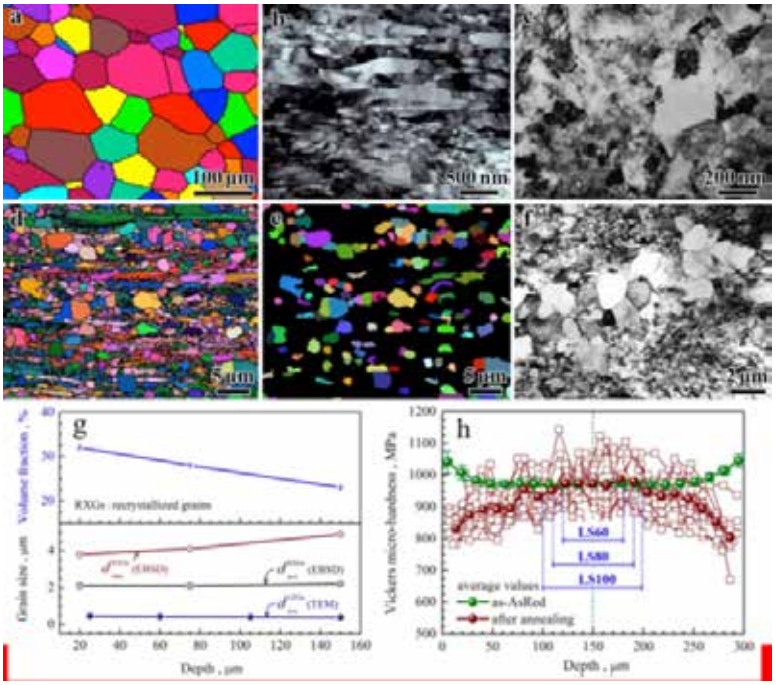
"No one has come close to matching nature's efficiency when it comes to wrapping and unwrapping nucleic acids," Yingling says. "We're trying to advance our understanding of precisely how that works."

Researchers find way to make metals stronger without sacrificing ductility

Researchers at NC State and the Chinese Academy of Sciences have developed a technique to make titanium stronger without sacrificing any of the metal's ductility - a combination that no one has achieved before. The researchers believe the technique could also be used for other metals, and the advance has potential applications for creating more energy-efficient vehicles.

"Historically, a material is either strong or ductile, but almost never both at the same time," says MSE Prof. Yuntian Zhu, co-corresponding author of a paper describing the work. "We've managed to get the best of both worlds. This will allow us to create strong materials for use in making lighter vehicles, but that are sufficiently ductile to prevent the material from suffering catastrophic failure under strain."

The key idea here is grain size, or the size of the crystals in the metal. Metals with a small grain size are stronger - meaning they can withstand more force before they start to deform. But metals with a small grain size are also less ductile, which means they can withstand less strain before breaking. Materials that aren't ductile won't bend or stretch much - they just snap. Conversely, metals with a large grain size are more ductile, but have lower strength.



The new technique manipulates the grain size to give the metal the strength of ultrafine-grained titanium but the ductility of coarse-grained titanium.

The researchers began by using asymmetric rolling to process a two-millimeter thick sheet of titanium. In asymmetric rolling, the sheet passes between two rollers that apply pressure to each side of the sheet, but one of the rollers rotates more quickly than the other. This not only presses the sheet thinner but, because of the different roller speeds, also creates a sheer strain in the metal.

In other words, the crystal structure within the titanium moves forward faster on the side of the fast roller than on the side of the slow roller. This effectively distorts and breaks down the crystalline structure, creating small grains in the material.

The researchers repeated the asymmetric rolling process until the metal was 0.3 millimeters thick, then exposed the sheet to 475 degrees Celsius for five minutes. This allowed some - but not all - of the small grains to consume each other and form large grains.

This second process creates a patchwork quilt of small and large grains. The large grains are laid out in long, narrow columns, with each column completely surrounded by a layer of small grains.

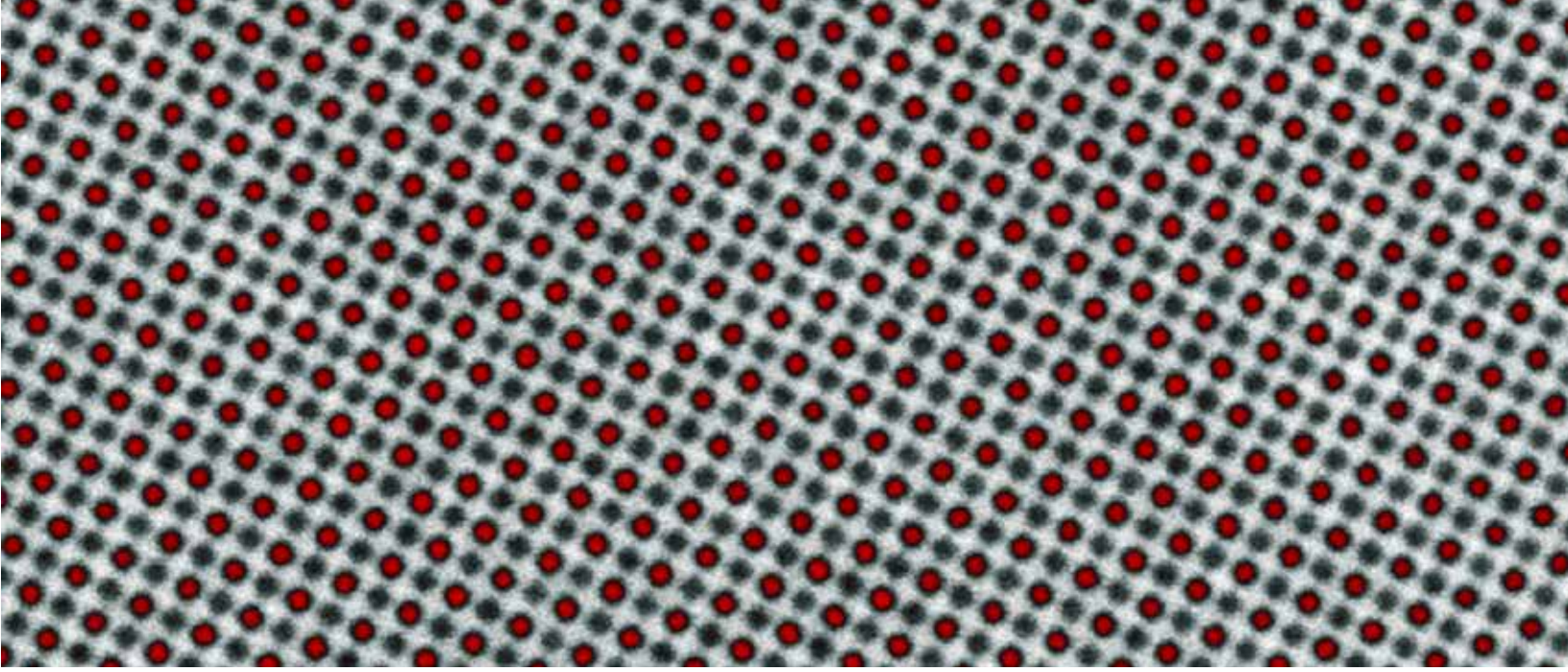
The resulting material is as strong as the small-grained titanium because the surrounding layer of small grains makes it difficult for the large grains to deform.

The material also retains the ductility of the large grains, because once enough strain is applied the small and large grains want to deform at different rates. But the different grain sizes have to coordinate with each other, much like traffic has to adjust to account for the slower cars on the road. The differential in grain sizes creates a phenomenon called strain hardening, in which the more the material is stretched, the harder it becomes

"In addition to creating a metal with an unprecedented combination of strength and ductility, this material has higher strain hardening than coarse-grained titanium - which was thought impossible," says X.L.Wu, co-corresponding and first author of the paper, who is based at the Chinese Academy of Sciences' Institute of Mechanics.

The processes used in the new technique are already in widespread industrial use. "They just haven't been used in this way" Wu says. "So this should be fairly easy to scale up."

Wu and Zhu are already working on projects to confirm that this technique would work for other metals and alloys.



Marrying big data and materials science

NC State is playing a lead role in an NSF-funded initiative to recruit and train researchers in new ways of applying advanced statistical tools to physical science data. In a partnership with NC Central University, the program aims to create a new generation of scientists who work at the crossroads of big data and materials science.

The five-year program, called Data-Enabled Science and Engineering of Atomic Structure (SEAS), was launched earlier this year and is supported by a $2.99 million grant from NSF.

"Technology has advanced to a point where we now can get an enormous amount of experimental information on a material's structure and behavior," says Beth Dickey, the director of SEAS and a professor in MSE. "Computational techniques have also advanced, giving us unprecedented amounts of data from modeling and simulation. That means we need to develop new, hybrid areas of expertise that allow us to capitalize on these humongous data sets in an efficient and meaningful way.

"Our goal with SEAS is to develop a cadre of graduate students at the nexus of characterization techniques – such as electron microscopy – and mathematical, statistical and modeling techniques, who can address big data challenges. This effort is consistent with NC State's data science initiative, which aims to advance the ways we understand, manage and make use of data," Dickey says.

SEAS plans to train at least 15 graduate students per year, starting in the second year of the program. There will also be a total of 12 paid graduate fellows per year, divided between NC State and NC Central.

"These trainees will become champions of this emerging, interdisciplinary field and global leaders in data-driven interdisciplinary STEM research," Dickey says.

And the work on finding new ways to integrate statistical approaches into MSE is already under way. A team led by MSE professor Jacob Jones has already developed a novel approach to materials characterization, using Bayesian statistical methods to glean new insights into the structure of materials.

"We want to understand the crystallographic structure of materials – such as where atoms are located in the matrix of a material – so that we have a basis for understanding how that structure affects a material's performance," Jones says. "This is a fundamentally new advance that will help us develop new materials that can be used in everything from electronics and manufacturing to vehicles and nanotechnologies."

The new approach allows researchers to better describe the inherent variability of a material's crystallographic structure, offering a richer understanding of a material's characteristics.

"This approach will allow us to analyze data from a wide variety of materials characterization techniques – all forms of spectroscopy, mass spectrometry, you name it – and more fully characterize all kinds of matter," says Jones, who is also the director of NC State's Analytical Instrumentation Facility, which houses many of these types of instruments.

A paper describing the new approach was published recently in *Nature's Scientific Reports*. The work was done in collaboration between MSE, statistics faculty at NC State and researchers at the National Institute of Standards and Technology and Oak Ridge National Laboratory.

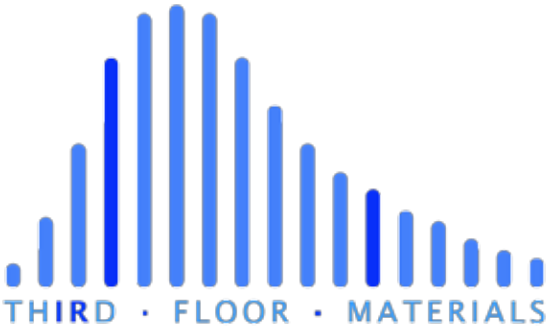
MSE has fostered six new companies in just the last year

In the past year, no fewer than six startups have sprung from groundbreaking discoveries in the department. Those six companies join more than a dozen other big names founded on the department's research — including Kyma, HexaTech, Nitronex, and multinational lighting and electronics giant Cree.

That sustained success over time is testament both to the strong infrastructure the university has built for technology transfer and to a philosophy of application that is intrinsic to materials science and engineering at NC State.

"We're the only department with both 'science' and 'engineering' in our name," says Justin Schwartz, Kobe Steel Distinguished Professor and department head since 2009. "We've always been committed to that continuum from idea to execution. Our research doesn't stop with publication; it's also about taking the next step, realizing the idea and putting products in people's hands."

Here are the six MSE startups taking that next step:



THIRD FLOOR MATERIALS

Infrared imaging — which allows us to "see" the heat emitted by objects in the world — currently requires cryogenic cooling to work. But materials science and engineering researcher Jon-Paul Maria is pioneering new, midwave infrared technology that requires no liquid refrigerants, opening the door for imaging devices that are less bulky, less expensive and require less power.

In 2015, a $75,000 grant from the Chancellor's Innovation Fund helped Maria design, build and begin testing a prototype of the technology. Since then, his three-person startup, Third Floor Materials, has generated almost $3.5 million in follow-up funding for NC State. The company has also received support from NASA and DARPA, whose interests span the range of potential applications for Maria's technology: from weather forecasting and space exploration to improving the situational awareness of troops on the battlefield.

CUSTOM NANO

Gold nanorods have long held promise for a host of applications — from biomedical imaging to potential cancer treatment — because of how they absorb and scatter light. But the quality of gold nanorods already on the market has tended to be highly variable, making it harder for researchers to unlock their potential.

Materials science and engineering Professor Joseph Tracy has developed new techniques that enable the creation of more consistent batches of gold nanorods — including a customizable silica coating that protects their shape and reduces their toxicity in the body. Tracy is now the technical advisor to Custom Nano, an NC State startup that has licensed his technology and aims to supply gold nanorods that meet the needs of researchers and private-sector companies.

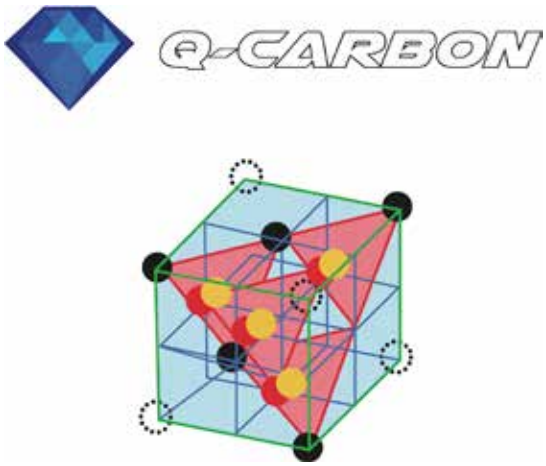
ATOMIX LLC

Atomix LLC is a start-up doing business as 2D Layer that was spun off from Dr. Linyou Cao's lab. It is dedicated to manufacturing large-scale high-quality atomically thin two-dimensional transition metal dichalcogenide materials for research and industry communities. These materials are widely believed as next-generation semiconductors promising the development of high-performance extremely flexible devices that are not possible at this moment. These may include flexible integrated circuits, flexible LEDs/displays, and smart sensors.

EAGLE POWER TECHNOLOGIES INC.

MSE department head Justin Schwartz has teamed up with Aaron Frahm and U.S. Air Force Major General (retired) David J. Eichorn to potentially bring to market a number of NC State inventions, including those related to superconducting magnet design and other transformational materials discovered and developed within MSE.

Eichorn's guiding interest is the creation of high-speed superconducting motors for commercial or military jets — pursuing a dramatic increase in specific power while reducing maintenance demands. Eagle Power currently holds seven patents ranging from supercomputing to superconducting and has already garnered significant private investment.



Q-CARBON LLC

Late last year, Jagdish Narayan, the John C.C. Fan Distinguished Chair Professor of Materials Science and Engineering at NC State, announced that he and his graduate student Anagh Bhaumik had discovered a new solid phase of carbon, distinct from graphite or diamond, which they dubbed "Q-carbon."

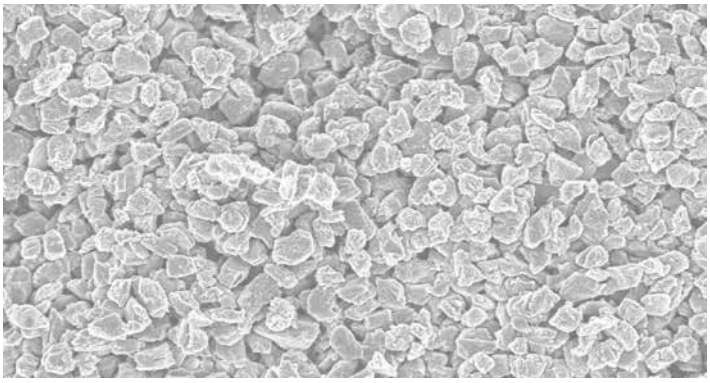
Q-carbon may be harder than diamond, is magnetic, electrically conductive, and glows when exposed to low levels of energy. That extraordinary combination of properties could be game-changing for drug delivery, display technologies, the creation of high-temperature switches and power electronics, or industrial processes like deep-sea drilling. With investor funding, Narayan has now teamed up with the founders of Eagle Power to launch Q-Carbon LLC, a startup that will explore and commercialize the potential applications of Narayan's research.

LUPINE MATERIALS AND TECHNOLOGIES

Superconducting magnets are essential to MRI machines, mass spectrometers and particle accelerators such as the world-famous Large Hadron Collider. They are also susceptible to sudden "quenches," when the magnet loses its ability to conduct electricity without resistance, generating heat that shuts the system down for several hours — if not longer.

Detecting and mitigating these quenches is one of the focuses of Lupine Materials and Technologies, a startup Schwartz has founded with two MSE postdoctoral researchers, Golsa Naderi and Ali Moballegh. By integrating optical fibers and thermally conductive insulation into magnet design, they hope to reduce quench behavior and enable a new generation of superconductive technologies. The company has already received a Small Business Technology Transfer grant and the support of the Department of Energy's Office of High-Energy Physics.

Introducing Q-carbon and Q-boron nitride: fundamental advances, real-world applications



MSE researchers, led by Professor Jagdish Narayan, have discovered a new form of solid carbon, called Q-carbon, which is distinct from graphite and diamond. They've also developed a technique for using Q-carbon to make diamond-related structures at room temperature and at ambient atmospheric pressure in air. And that – if you'll excuse the pun – barely scratches the surface.

"The only place Q-carbon may be found in the natural world would be possibly in the core of some planets," says Narayan, the John C.C. Fan Distinguished Chair Professor of Materials Science and Engineering.

But the material has a host of potential applications that are very down to Earth. Q-carbon has some unusual characteristics: it is ferromagnetic – which other solid forms of carbon are not; it may be harder than diamond; and it glows when exposed to even low levels of energy. It can also be used to create a variety of single-crystal diamond objects.

As a result, it holds promise for use in everything from cutting tools to … well, who knows? Researchers are still characterizing its properties and assessing its potential for use in a wide variety of fields.

Narayan and Ph.D. student Anagh Bhaumik – his partner in the Q-carbon discovery – have also discovered a new form of boron nitride (Q-BN), which has potential applications for both manufacturing tools and electronic displays. What's more, the researchers have also developed a faster, less-expensive technique for creating cubic boron nitride (c-BN) at ambient temperatures and air pressure, which has a suite of applications, including the development of advanced power grid technologies.

In addition, Narayan, Bhaumik and postdoctoral researcher Weizong Xu also developed a technique for depositing diamond on the surface of c-BN, integrating the two materials into a single crystalline structure. This advance should expedite the development of technologies to take advantage of Narayan's work on creating c-BN in the first place. In fact, Narayan has already co-founded a company, Q-Carbon LLC, which has licensed the technique and is working to commercialize it for multiple applications (see story on page 8).

The Q-carbon, Q-BN and c-BN research is being done with support from the National Science Foundation.

An interdisciplinary approach for materials design

One of the most promising – and challenging – frontiers in materials research is the marriage of advanced statistical techniques and materials science. And one of the young researchers forging ahead in the field is Srikanth Patala, an assistant professor in MSE.

Patala is particularly interested in using a suite of statistical tools and computational models to advance our understanding of material defects – the atomic anomalies in a material's crystalline structure that can significantly enhance or degrade that material's properties.

Earlier this year, Patala received a highly sought-after NSF CAREER Award to focus on just this area. But the importance of the work, and Patala's expertise, are not the only reasons NSF singled him out.

"To address these research questions about defects, my team is going to have to create new computational tools that can be applied at the nexus of statistics and materials science and engineering," Patala says. "I plan to make those tools open source, so anyone can use them. I'll also be making all of my data publicly available and developing online tutorials that allow other researchers to use them effectively.

"My goal is to advance our fundamental understanding of materials science – not just my lab's understanding of materials science," Patala says.

And Patala's interest isn't confined to computational work.

"Statistical tools give us a new perspective on longstanding challenges, but we need to find meaningful ways to link computational findings with experimental observations," Patala says.

And Patala is already publishing in this field. A 2016 article in the Nature journal *Computational Materials* from Patala and collaborators at MIT focused on developing high-throughput experimental techniques that will allow Patala to validate – or invalidate – his ongoing work with new statistical tools.

"It's not enough to think your results are right, you have to know they're right," Patala says. "We're tilting at some ambitious research challenges, but we see them as opportunities. And we relish the work."

Five Years, Six CAREER Awards

Patala is only the most recent recipient of NSF's prestigious NSF CAREER awards, in what has been an impressive run for MSE.

"Six of the seven CAREER awards in MSE's history have come in the last five years," says Justin Schwartz, Kobe Steel Distinguished Professor and department head of MSE.

"These awards show that we are being aggressive about recruiting top talent," Schwartz says. "We are not just building for the future, but shaping what the future of materials research will look like."

Recipients since 2011 include Yaroslava Yingling, Doug Irving, Joe Tracy, Linyou Cao and James LeBeau. Professor Jon-Paul Maria received his CAREER award in 2006.

Jennifer and Jake Hooks

Alumnus keeps giving back in service and philanthropy to the department and college

Growing up in Fremont in rural Wayne County, Jake Hooks always knew where he would go to school.

After all, his father, J.T. Hooks Sr., was the captain of NC State's freshman men's basketball team in 1924. So as a boy, Jake could often be found decked out in red.

"I always knew that I wanted to go to NC State because that's where my dad went."

Jake Hooks has carried that love for NC State throughout his life, and has given of his money and his time to serve the university, the College of Engineering and the MSE department.

He and his wife, Jennifer, also support UNC Greensboro (UNCG), where Jennifer and many of the women in her family earned their degrees.

Jake graduated in 1978 with a degree in materials engineering and worked as a product engineer before moving into management. He retired in 2013 as president of Eaton Corporation Automotive North America.

Hooks had worked in construction and considered taking up civil engineering when he arrived in Raleigh. But he found the study of materials fascinating, and being from a small town, he liked the fact that the Department of Materials Engineering was one of the smaller ones in the College.

From studying engineering, Hooks says, he learned important skills that he carried into business management, including an ability to see situations as they actually are instead of the way he'd like for them to be. With that clear-eyed vision, he was able to use an engineer's problem-solving skills to get things done. Put those two things together, he said, and you can have a good understanding of what is possible and what is not in a certain amount of time.

"That degree served me very well," Hooks said. "It opened a lot of doors."

The Hookses lived in northwest Ohio and Michigan during Jake's career, but they always donated to NC State. Eaton has a large presence in North Carolina and recruited some NC State engineers. But it wasn't until later in life that Jake became more involved with the university.

In 2011, he was asked to speak to incoming engineering first-year students at the annual College of Engineering Welcome Event. Then he was recruited to the board of directors for the NC State Engineering Foundation. He currently serves as chairman of the board's development committee.

"That's one of the fun things coming back and getting to know the people on the Foundation board," Jake said. "It's kind of a reminder of why I went to NC State, getting to know people of that caliber."

Jennifer Smith Hooks earned a degree in early childhood education at UNCG and worked as a teacher. Her grandmother graduated from the same school, then called the State Normal and Industrial College, in 1914. Her mother earned a degree there in 1944, when it was called the North Carolina College for Women; three of her aunts also graduated from the College for Women. Jennifer has remained active as a member of the School of Education's advisory board and as that board's representative on the UNCG Alumni Association's board of directors.

Tyler Pardue, a junior in MSE, is a recipient of the Jacob T. Hooks, Sr. Scholarship in Materials Science and Engineering.

"I am someone who likes to work hard and plan ahead," he said. "With support from the Jacob T. Hooks scholarship I have been able to do just that. It has lessened the financial load that comes with college and allowed me to focus more on

my classes and lab work. Without the aid of this scholarship, I would likely get a part-time job to help with finances. I now have the opportunity to devote time each week to lab work that will make me a competitive candidate for future internships and jobs. I am very thankful to Jake and Jennifer Hooks for their generosity and philanthropy. I will continue to take full advantage of the opportunities they have afforded me."

Along with that scholarship, Jake and Jennifer have made a bequest that will create a distinguished professorship in MSE, provide additional funding for their undergraduate scholarship and give discretionary support to the College of Engineering to help meet future critical needs. They have also made a gift to support construction of the planned Engineering Oval building, which will allow two more of the College's academic departments to move to Centennial Campus.

Construction of the building is a major focus for the College and Jake, as chairman of the development committee for the Foundation board, sees it as a priority.

"I think it's going to be great to see that building take shape," he said.

Longtime donors' volunteer service and generosity impact multiple initiatives at NC State and beyond

Tom and Mimi Cunningham

Tom and Mimi Cunningham spent their careers helping young people. They haven't stopped in retirement.

Tom is a two-time graduate of what was then the Department of Materials Engineering. In addition to his career at General Electric Nuclear Energy in engineering and management, he spent more than 20 years as a lead recruiter for GE. His wife, Mimi Cunningham, holds bachelor's and master's degrees in journalism from the University of South Carolina (USC) and spent 26 years working in news and public relations at UNC Wilmington (UNCW).

While he was interviewing the best and brightest young engineers (including several from NC State), she was working with student interns in UNCW's university relations office. That passion for education and young people has stuck with the couple, who have lived in Wilmington since 1974. They support NC State, UNCW and USC and are active in other community-oriented endeavors.

Their longtime support of the department, college and university helps make a difference for students and faculty members, providing the additional financial help that allows them to reach their full potential.

The Cunninghams' new endowment, along with a planned gift, will directly benefit the University's Park Scholarships program. Established by the Park Foundation, the Park Scholarships program has supported 17 classes of Park Scholars with full scholarships to NC State. The Cunninghams' gifts will provide additional scholarship opportunities in this program, with a particular focus on students who want to study materials science and engineering.

Tom Cunningham has long been involved with the Park Scholarships program, as a member and chair of the Sandhills selection committee and by leading efforts to promote the scholarship through innovative initiatives and annual events. "It has meant so much to me," he said of his involvement with the program. "If I can give something back, I will."

Tom Cunningham earned a bachelor's degree in materials engineering from NC State in 1971 and a master's in the same discipline in 1974. During his career with GE, he recruited more than 50 NC State engineering students for the company's management and engineering programs.

He was inducted into the department's MSE Alumni Hall of Fame in the inaugural class in 2015.

The Cunninghams are longtime financial supporters of the MSE department who have endowed an undergraduate scholarship, established a planned gift to benefit this scholarship and are members of the Dean's Circle, the College's leadership annual giving program. Bethany Rutherford, a senior in MSE, is a recipient of the Tom and Mimi Cunningham Scholarship in Materials Science and Engineering.

"Mr. and Mrs. Cunningham's support helps me not only financially, but also mentally," she said. "Knowing that distinguished alumni believe that I will be successful in pursuing a Ph.D. has helped my confidence more than they know. Thanks to their help I am also able to spend time helping the next generation become more engaged in STEM through programs like Science Olympiad."

The Cunninghams are also members of the university's R. Stanhope Pullen Society and Riddick Lifetime Giving Society. Mimi Cunningham has been an active member and leader with several organizations, including the Wilmington Rotary Club, WHQR public radio, the American Association of University Women, the Thalian Hall Center for the Performing Arts and the Landfall Foundation. The Mimi Cunningham Speaker Series Endowment at UNCW brings distinguished lecturers to campus as part of the university's Leadership Lecture Series. Tom is a board member and twice president of the GE Retirees Association in Wilmington. He was recently appointed to serve on the UNCW board of visitors.

"We've got a full life and a lot of it revolves around the universities," he said.

MSE young alumnus spotlight

NAME: Dr. Aaron Johnston-Peck

YEAR: 2011

DEGREE: Ph.D. in materials science and engineering

RESIDENCE: Germantown, Md.

INVOLVEMENT IN MSE: Aaron was Prof. Joe Tracy's first Ph.D. student. During Aaron's graduate studies on magnetic nanoparticles, he became an expert in electron microscopy. After completing a postdoctoral position at Brookhaven National Laboratory and a National Research Council postdoc at the National Institute of Standards and Technology (NIST), he continues to work as an electron microscopist at NIST. Aaron collaborates with many research groups to learn about structure-property relationships in nanoparticles, especially for applications in catalysis. Since graduating, Aaron has become a supporter of the MSE Enhancement Fund, the Department's sole source of discretionary funding that enables MSE to respond quickly and effectively to critical opportunities and needs — an important element in the Department's long-term success. In the spring 2016, Aaron encouraged more than 300 MSE young alumni through an electronic appeal to make an investment in the Department (no matter the amount) and become an active participant in MSE's efforts to build and cement a culture of philanthropy.

QUOTE: *"Having received from the MSE staff and faculty an immense level of support and guidance, it is a pleasure to contribute and help ensure that future students will be afforded opportunities to pursue their professional and academic goals."*

Q&A with new MSE Assistant Professor Victoria Miller

MSE's goal is to bring some of the best and brightest minds in materials research to NC State. We're excited about these new additions. To help you stay abreast of what these new researchers are up to, we decided to sit down with one of them – Dr. Victoria Miller, who will start at NC State next year.

MSE: What drew you to NC State?

MILLER: *Without question, it was the students. While I was a Ph.D. student at UC Santa Barbara, my peers who had graduated from NC State were some of my favorite people with whom to work; they were always bright, curious, and excited about the research. That culture was absolutely evident — both in the students and the faculty — when I visited the campus. NC State is still the only place that I have given a seminar where students contacted me in the subsequent weeks to ask follow-up questions.*

> *"While I was a Ph.D. student at UC Santa Barbara, my peers who had graduated from NC State were some of my favorite people with whom to work; they were always bright, curious, and excited about the research."*
>
> -VICTORIA MILLER

MSE: What sort of research do you do, and what sort of applications does that research lend itself to?

MILLER: *I lived just outside of Detroit for the first two decades of my life, so the needs of the automotive industry definitely informed my interest in the field of materials. In vehicles, both automotive and aerospace, using lighter materials can dramatically improve fuel economy and performance. The fundamental problem is that deformation processing of light metals, especially titanium and magnesium alloys, poses challenges that are different from more conventional materials like aluminum and steel. My research seeks to identify and control the fundamental differences in their behavior during thermomechanical processing, particularly the deformation and recrystallization mechanisms, so that new economical processing pathways can be developed and we can actually see these alloys be implemented.*

MSE: How long have you been working with light metals?

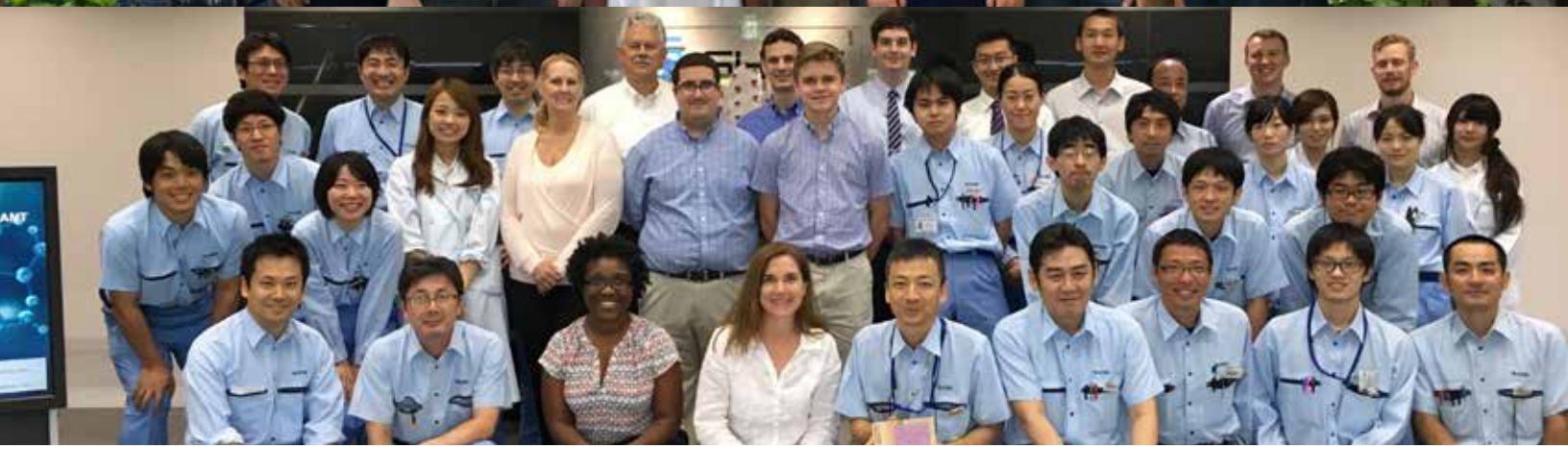
MILLER: *I actually started working on light metals as a high school intern in the auto industry (before I really knew anything about materials science) and I haven't looked back. On my first day my boss handed me a cast magnesium part, which I promptly fumbled because I had greatly overestimated the weight. That very clumsy interaction provided more motivation for the research I was doing at the time than any numerical analyses of potential weight savings and made me fall in love with the idea of helping to build a magnesium car.*

MSE: Are there any specific projects in development that you're particularly excited about?

MILLER: *The project I am most excited about right now is developing an experimental framework to investigate the rearrangement of groups of one-dimensional crystalline defects (dislocations) into two-dimensional defects (grain and subgrain boundaries) during thermomechanical processing. This transition during the recrystallization process is one of the important factors that determines the macroscopic properties of the metal after processing, including the fracture toughness, fatigue behavior, and even just the material strength. A more fundamental understanding of these early stages of defect rearrangement would aid in a wide range of important industrial processes — everything from developing titanium forging pathways that could extend the lifetime of jet engine components to allowing the metal chassis of a cell phone to be made thinner and lighter.*

MSE: Will you be involved in any interdisciplinary initiatives at NC State?

MILLER: *I'm very excited about several potential collaborations both within MSE and with individuals in the Departments of Chemical and Biomolecular Engineering, Mechanical and Aerospace Engineering and Industrial and Systems Engineering; however, a lot of the details are still being worked out before my start date in August 2017.*



Center for Dielectrics and Piezoelectrics meeting strengthens bonds with leading manufacturers

The National Science Foundation-funded Center for Dielectrics and Piezoelectrics (CDP) hosted its semi-annual technical review meeting in Kyoto, Japan June 16-17 as a means of technology and knowledge transfer to its member companies.

CDP students, postdoctoral scholars and faculty members from NC State and The Pennsylvania State University, along with academic and industry guests from several universities and companies, presented their most recent scientific accomplishments and technical breakthroughs in dielectrics research. Students and postdocs from Penn State and NC State also had a unique opportunity to visit Murata Manufacturing and Shoei Chemical for scientific, technical and cultural exchanges.

Visits to Murata Manufacturing Nagaokakyo and Yasu plants and Shoei Chemical's Tosu plant marked another level of the relationship between the CDP and its member companies. The CDP students and postdocs presented their research, interacted with local engineers, and toured through analytical facilities, while also having an opportunity to learn about the companies' histories and cultures. For some students, it was their first chance to see how research is performed in a world-leading manufacturing facility and communicate with engineers working in a different culture. "Our visit to Japan was a wonderful learning experience, both academically and culturally. Face-to-face collaboration with industry engineers at Murata and Shoei was a wonderful opportunity for aiding my graduate career," said Richard Floyd, a Ph.D. candidate at NC State and NSF graduate research fellow.

MSE Professor Elizabeth Dickey, CDP director, says "We were extremely pleased to host the semiannual meeting of the CDP in Japan, as it provided a tremendous opportunity to interact with our Japanese members. The scientific and technical exchanges at the meeting and company visits were truly outstanding, giving our students a unique opportunity to present their research in an international setting. We are incredibly grateful to Murata Manufacturing and Shoei Chemical for being such gracious hosts."

The CDP is an NSF industry/university cooperative research center (I/UCRC) that aims to train young scientists and support industries in the dielectrics and piezoelectrics field. CDP is a joint collaboration between North Carolina State University and The Pennsylvania State University and is supported by the NSF and CDP members. To learn more visit **www.cdp.ncsu.edu**.

The 2015 inaugural class included 16 inductees

Second Annual MSE alumni Hall of Fame

The Department of Materials Science and Engineering at NC State University is proud to honor the accomplishments of our outstanding graduates through the annual MSE Alumni Hall of Fame.

This extraordinary recognition celebrates MSE alumni who have used their education to excel in a profession, career, and/or service. Our alumni are at the core of the department, representing the agents and ambassadors that have made groundbreaking contributions in the translating and practice of materials science and engineering and beyond, and we hope this meaningful accolade will inspire current and future students.

In 2015, with more than 1,800 MSE alumni, only 16 graduates were selected for this inaugural class, making this a truly noteworthy distinction.

This year, we look forward to honoring the 2016 cohort of inductees in a special ceremony where past inductees, faculty members, students, and MSE's External Advisory Board will pay tribute to this exceptional group of alumni. Please join us in congratulating the following 2016 MSE Alumni Hall of Fame inductees:

- Dr. Zlatko Sitar, Ph.D. MSE '90, Raleigh, NC
- Mr. John DuPlesis, B.S. MSE and Nuclear '58 and M.S. MSE '61, Elizabethtown, Ky.
- Dr. Jea-Gun Park, Ph.D. MSE '94, Seoul, South Korea
- Dr. Haiyan Wang, Ph.D. MSE '02, West Lafayette, Ind.
- Dr. Paul Besser, B.S. MSE '88, Sunnyvale, Calif.

For complete biographical information on our outstanding alumni inductees, please visit **www.mse.ncsu.edu/alumni/hall-of-fame**.

On behalf of the department, we would like to extend our thanks and sincerest appreciation to the MSE Alumni Hall of Fame Committee. Their diligent efforts were invaluable in the review and selection process. Our gratitude is bestowed to the following members for their time, dedication and service: Dr. Cheryl Cass, Dr. Ramon Collazo, Mr. Thomas G. Cunningham (chair) (B.S. MSE '71 and M.S. MSE '74), Dr. Barry Farmer, and Mr. Jacob T. Hooks (B.S. MSE '78).

AWARDS & HONORS

Faculty Awards

Dr. Donald Brenner, second from left, receives the Holladay Medal from Chancellor Randy Woodson. Also shown, from left, are Jimmy Clark, Thomas Cabaniss, Susan Ward and Dewayne Washington.

PROFESSOR DONALD BRENNER received the Alexander Quarles Holladay Medal for Excellence during NC State's 2016 Celebration of Faculty Excellence on May 3. The annual event honors faculty members who have won prestigious state, national and international awards and accolades throughout the academic year. Chancellor Randy Woodson presented five professors with the Holladay Medal, NC State's highest honor in recognition of faculty achievement.

PROFESSOR SRIKANTH PATALA received both a National Science Foundation Faculty Early Career Development Program award for his research proposal "Mapping the Genome of Metallic Grain Boundaries – Structure, Thermodynamics and Kinetics," and an Air Force Office of Scientific Research Young Investigator Program award for his research proposal "A Machine-Learning Approach Towards Quantitative Structure-Property Relationships for Metallic Interfaces."

PROFESSOR VERONICA AUGUSTYN won a 2016 Ralph E. Powe Junior Faculty Enhancement Award. Augustyn is one of 35 nationwide recipients of the award. The Ralph E. Powe Junior Faculty Enhancement Awards provide funding for research by junior faculty at Oak Ridge Associated Universities. These awards enrich the research and professional growth of young faculty and result in new funding opportunities. The award amount provided by Oak Ridge Associated Universities (ORAU) is $5,000. NC State, as a member of ORAU, is required to match that award with at least an additional $5,000. Augustyn plans to use the award to study the electrochemical interface of metal oxides in contact with aqueous electrolytes. Specifically, the research will involve the synthesis of redox-active metal oxide nanosheets which will be deposited on conductive and flat substrates, such as glassy carbon.

PROFESSOR JAGDISH NARAYAN won the 2016 Emerging Materials Research Prize.

PROFESSOR RICHARD SPONTAK was named an NC State Distinguished Professor (2016), was selected a Goodnight Fellow in the NC State Goodnight Scholars Program (2016-17), received a Society of Plastics Engineers International Award (2015), was named an NC State Alumni

Distinguished Graduate Professor (2015), and was elected as a member of the Norwegian Academy of Technological Sciences (2015).

PROFESSOR JOSEPH TRACY was named a University Faculty Scholar for 2015–20.

PROFESSOR YUNTIAN ZHU made Thomson Reuters' 2016 edition list of the year's most highly cited researchers.

PROFESSOR JON-PAUL MARIA received a grant from the NC State Chancellor's Innovation Fund for the 2015-16 fiscal year. For the past five years, the fund has helped NC State innovators by providing the financial support necessary to develop research findings into viable business opportunities. Maria received the award to help drive his research into technology that can create mid-range infrared images without relying on bulky and expensive cooling equipment.

PROFESSOR K. L. MURTY, who holds joint appointments in MSE and the Department of Nuclear Engineering, was selected to receive Honorary Membership of the Indian Institute of Metals (IIM) during its Annual Technical Meeting on Nov. 14th, 2015, in Coimbatore, India. Honorary Membership recognizes distinguished services to the metallurgical profession and to the Indian Institute of Metals, and is the highest honor bestowed by IIM. Dr. Murty has been a Life Fellow of the institute since 1996 and has been serving as external examiner for doctoral degree students (about one to two per year since 2003) in Indian institutions such as IITs, University of Madras, Jadavpur University, Banaras Hindu University and Homi Bhabha National Institute.

Student Awards

GRADUATE STUDENT AWARDS

■ **Sumeet Mishra**, a Ph.D. student in Prof. Joseph Tracy's group, received a 2015 Gold Graduate Student Award (GSA) from the Materials Research Society (MRS) for his work using chains of magnetic nanoparticles to control the actuation of elastomer thin films, which has applications in soft robotics. The GSA is "intended to honor and encourage graduate students whose academic achievements and current materials research display a high level of excellence and distinction." After an initial selection as finalist for a GSA, Sumeet was awarded a Gold GSA based on the evaluation of his oral presentation before a panel of judges at the Fall 2015 MRS meeting in Boston.

■ The Electronics Division of the American Ceramics Society (ACerS) gave out awards for "outstanding student work." Among the two sets of top-three posters and presentations at the Electronic Materials and Applications meeting in Orlando, Fla., were three MSE students: For poster awards, **Daniel M. Long** came in first place with his poster titled, "Band Alignment Characterization of Barium Titanate Interfaces." Also in the top three for poster awards was **Dong Hou**, who took home third place with his poster, "Temperature-induced Average and Local Structural Changes of $BaTiO_3$-$Bi(Zn_{0.5}Ti_{0.5})O_3$." For oral presentations, first place went to **Kyle P. Kelley**, whose presentation title was "Doping control in epitaxial thin films via reactive RF co-sputtering."

■ **Dr. Boopathy Kombaiah**, a former Ph.D. student in MSE guided by Prof. K.L. Murty, was selected to receive the 2015 ANS-Mark Mills award for his recent research article entitled "Dislocation cross-slip controlled creep in Zircaloy-4 at high stresses" published in *Materials Science and Engineering*: A_{623} (2015) 114-123. The official presentation of a plaque and a monetary award of $500 was made during the 2015 ANS Winter Meeting in Washington, DC in Nov. 2015. Kombaiah graduated in May 2015 and is now working as a post-doctoral fellow at Carnegie Mellon University in Pittsburgh, Penn.

■ **Alexandria Cruz** and **Preston Bowes** were recently awarded a National Science Foundation (NSF) Graduate Research Fellowship, joining five other MSE graduate students with this distinction: Matthew Burch, Houston Dycus, Richard Floyd, Everett Grimley and Jessica Nash. The department has also welcomed Trent Borman, who was also awarded an NSF Fellowship, into our graduate program, bringing the total to eight. The NSF Graduate Research Fellowship Program (GFRP)

is one of the oldest and most prestigious fellowship programs in the U.S. and provides students with three years of financial support to pursue their graduate degree.

■ An interdisciplinary team of NC State engineering undergraduate and graduate students won 2nd place (and $300 for their project) at the Materials Research Society 2016 Spring Meeting "Sustainability in My Community" competition in Phoenix, Ariz. Their submission, entitled "Building the SciBridge between Africa and the U.S.," focused on their efforts to improve engineering education in sustainable energy in developing countries in sub-Saharan Africa as well as increasing research collaborations between African and U.S. scientists. The team consisted of MSE undergraduates **Mohanad Alsaftawi, Tyler Boquet-Caron, Julian Brodie, Mohammad Omary,** and **Andrew Squires;** MSE graduates **Shelby Boyd, Alexandria Cruz,** and **Ruocun (John) Wang;** and **MAE grads Christopher Boggs, Ismail Mohamed, Megan Watkins,** and **Santhosh Radhakrishnan.**

■ WarpSpec, Inc. was named the Grand Prize Winner in the Licensing Executives Society (LES) Foundation 2015-2016 International Business Plan Competition and was awarded $10,000 to further its work. WarpSpec began as a NC State Jenkins MBA graduate team project with an innovative approach to detecting food-borne pathogens. Jenkins MBA student Rafael Estevez co-founded the startup in May 2015 following a fall 2014 semester entrepreneurship class with **Jordan Moering**, an MSE graduate student and colleague in the Jenkins MBA entrepreneurship and technology commercialization (HiTEC) concentration. Both Estevez and Moering graduated from NC State in May 2016. WarpSpec, Inc. is developing an in-line system that scans meat products in real time for pathogens like Salmonella.

■ **Yiling Yu** and **Yifei Yu**, Ph.D. students in Prof. Cao's group, were selected for the 2015 Chinese Government Award for Outstanding Self-Financed Students Abroad. Founded by the Chinese government in 2003 and sponsored by the China Scholarship Council (CSC), the award recognizes the academic excellent achievements of non-government-funded Chinese students studying overseas among 29 countries around the world and is granted across all fields of study. This award is presented to 500 students worldwide and includes a $6,000 prize and a CSC-issued certificate. Yifei Yu also received a 2016 Silver Graduate Student Award (GSA) from the Materials Research Society (MRS) for his work "Engineering Substrate Interactions for High Luminescence Efficiency of Transition Metal Dichalcogenide Monolayers." The MRS Graduate Student Awards are intended to honor and encourage graduate students whose academic achievements and current materials research display a high order of excellence and distinction.

■ **Matt Cabral** (LeBeau and Dickey) won the Student Scholar Award at the 2016 Microscopy and Microanalysis conference.

■ **Houston Dycus** (and advisor LeBeau) received a 2016 best paper in Materials Applications Category in the journal *Microscopy and Microanalysis* for a paper titled, "Accurate Nanoscale Crystallography in Real-Space Using Scanning Transmission Electron Microscopy."

■ **Federico Scurti** (Schwartz group) won first place, Triangle Student Research Competition (TSRC 2016) in the electrochemistry, electronics and sensors category for his research work titled "Self-monitoring SMART REBCO coated conductor."

■ **James Peerless** received NCSG/WRRI funding to study water resources and will study a novel technology to filter and desalinate brackish groundwater. The design involves combining common activated carbon with innovative nanotechnology research. Using computer simulations, Peerless will design and optimize the model to predict purification effectiveness before moving to fabrication.

■ **Preston Bowes** (Irving group) received the 2016 - NSF GRFP fellowship and DoD NDSEG fellowship.

UNDERGRADUATE STUDENT AWARDS

■ **Rachel Goh** won the Navy Achievement Medal and Naval Science Institute Leadership Award.

■ **Zachary Davis** won the DAAD Research Internship in Science and Engineering (RISE) and an NC State Fellowship Advising Office Super Curricular SEED Grant.

■ **Jason Lin** won the NC State Housing Spirit of the Village Award.

■ **Thomas Oweida** won the NC State Provost's Professional Experience Program (PEP) Award.

■ **Kelsey Beal** won the Society of Plastics Engineers Scholarship.

■ **Jonathan Gillen** won first place in an Oklahoma University REU Poster Session and was selected to present at NSF REU Symposium, Arlington, Va.

■ **Hanan ("Alex") Hsain** won first place in the undergraduate research and IMPACT Award at Appalachian Energy Summit 2016 and was named a 2015 NC Space Grant Scholar.

■ **Joshua Dickerson** received an NC State Undergraduate Research Grant.

■ **Paul Nolan** was elected as Student Body President and ex officio voting member of the Board of Trustees.

OTHER STUDENT AWARDS

■ **Vamsi Varanasi**, an Enloe high school student studying with Prof. Joseph Tracy's group, was named an Intel Science Talent Search semifinalist for 2016.

■ REU student **Marissa Schmauch** (Tracy group) received a Gulf Coast Undergraduate Research Symposium Outstanding Presentation Award for 2015.

Dr. Barry Farmer

MSE External Advisory Board

We are pleased to welcome new leadership and two members to the MSE External Advisory Board. Dr. Barry Farmer and alumna Karen Bisi (B.S. MSE '90) have accepted the roles of chair and vice chair, respectively. In new membership, Brigadier General (retired) Leodis Jennings (B.S. MSE '83) and Dr. Nasser Karam (Ph.D. MSE '85) have joined this dynamic cohort.

We would also like to express our sincere thanks to two members who have left the board, Prof. Reza Abbaschian, dean of engineering, University of California, Riverside, who served as chair; and Prof. Enrique Lavernia, provost and executive vice chancellor, University of California, Irvine, who served as vice-chair. The leadership they provided to the board, and their thoughtful advice to the department, have played important roles in our success.

The External Advisory Board (EAB) is a group of outstanding thought leaders dedicated to providing experience and expertise for the department's continued success. These MSE advocates play a major role in setting the direction for research, education and industry partnerships. Their collective insight empowers the department to sustain its excellence and relevance in the field of materials science and engineering. The department is sincerely grateful for their commitment, support, and friendship.

- **Dr. Terry Aselage**, Senior Manager of the Materials Synthesis and Processing Technology Group, Sandia National Laboratories
- **Dr. Paul Besser** (chair), Senior Technology Director, Lam Research Corporation
- **Mrs. Karen F. Bisi** (vice chair), Branch Manager, Cer-Met, Inc.
- **Dr. Rich Colton**, Superintendent Chemistry Division (retired), Naval Research Laboratory
- **Dr. John Edmond**, Co-founder, Cree, Inc.
- **Dr. John C.C. Fan**, Chief Executive Officer, Kopin Corporation, Inc.
- **Dr. Barry Farmer**, Chief Scientist, Materials and Manufacturing Directorate (retired), Air Force Research Laboratory
- **Mr. John Freeman**, President, Cer-Met, Inc.
- **Dr. Don Gubser**, Superintendent of the Materials Science and Technology Division (retired), Naval Research Laboratory
- **Dr. Sung Han**, Director of Technology, Eastman Chemical Company
- **Mr. Leodis Jennings**, Brigadier General (retired), United States Army
- **Dr. Nasser Karam**, Chief Technology Officer (retired), Boeing Spectrolab
- **Dr. Brian Laughlin**, Technical and R&D Supervisor for the MCM Advanced Materials, DuPont
- **Professor Jennifer Lewis**, Hansjorg Wyss Professor of Biologically Inspired Engineering, Harvard University
- **Mr. Jim Lewis**, Manager Rolling and Finishing, Nucor Steel
- **Dr. Henry Lippard**, Manager, Nickel and Iron Process Metallurgy, ATI Allvac
- **Dr. Brent Neal**, R&D Manager, Milliken
- **Dr. Julie P. Martin**, Assistant Professor in the Department of Engineering and Science Education, Clemson University
- **Mr. Chris Story**, Senior Vice President of Global Operations, CommScope
- **Dr. Stephen Streiffer**, Deputy Associate Laboratory Director, Argonne National Laboratory
- **Dr. Steve Zinkle**, Governor's Chair for Nuclear Materials, University of Tennessee, Knoxville

The establishment of the Davis Distinguished Lecture

In spring 2010, the department initiated the Robert F. Davis Distinguished Lecture series honoring Professor Emeritus Robert F. Davis, who made transformative contributions during his time at NC State from 1972-2004 to advance the department and help launch so many successful careers. Teams of his student scholars have established several corporations including Cree, Inc. and the Nitronex Corporation as an outgrowth of the research they conducted under his direction.

After retiring from NC State in 2004, Dr. Davis became the John and Clare Bertucci Distinguished Professor of Materials Science and Engineering at Carnegie Mellon University. He received his B.S. degree in ceramic engineering from NC State in 1964 and, M.S. and Ph.D. degrees in materials science and engineering from The Pennsylvania State University and the University of California, Berkeley in 1966 and 1970, respectively.

To build special programs like this lecture series, universities rely on private financial contributions, usually from dedicated alumni and friends. As a tribute to Dr. Davis' legacy, his former graduate students collectively supported this effort through philanthropic contributions to help cement the continuity of this annual lecture. Dr. Davis also has made a generous lead gift to this fund. This combined funding is being endowed to generate income that will build and maintain a high-profile lecture series, bringing in speakers who will greatly enhance the department and the experiences we are able to provide for our students and faculty members.

To learn more about giving opportunities that will further sustain the Davis Distinguished Lecture, please contact the NC State Engineering Foundation at 919.515.9958.

Goddard delivers 2016 Davis Lecture

The 2016 Robert F. Davis Distinguished Lecture was given by Prof. William A. Goddard, the Charles and Mary Ferkel Professor of Chemistry, Materials Science and Applied Physics at the California Institute of Technology, and the director of the Cal. Tech. Materials and Process Simulation Center. The Davis Lecture, named for a former NC State faculty member, is one of the premiere lecture series in materials science and engineering in the United States. A pioneer in using computational methods to predict materials' properties from the fundamental quantum level, Prof. Goddard gave the lecture "First Principles Based Multi-Scale Multi-Paradigm Methods for Applications to Complex Material." The talk highlighted the development of new computational methods and their application to a variety of challenging problems, including understanding the role of excited electronic states in brittle fracture, improving the ductility and strength of ceramics, designing less sensitive explosives, and modeling surface reactions such as CO_2 reduction on copper.

The 2017 Davis Lecture will be given by Dr. Nava Setter, director of the Ceramics Laboratory of the École Polytechnique Fédérale de Lausanne, Switzerland, on April 7, 2017. Dr. Setter's research interests include the properties of piezo- and ferroelectric materials, and their use in new technologies. She has published more than 450 scientific and technical papers, and is a Fellow of the Swiss Academy of Technical Sciences, the Institute of Electrical and Electronic Engineers (IEEE), and the World Academy of Ceramics.

Yingling, Cao, LeBeau promoted

The department proudly announced three faculty promotions this year. Professor Yaroslava Yingling was promoted from associate professor to professor and Professors Linyou Cao and James LeBeau were promoted from tenure-track assistant professor to associate professor with tenure.

Yaroslava Yingling

YINGLING joined the department in 2007 after serving as a postdoctoral fellow in the Department of Chemistry at the Pennsylvania State University and subsequently as a CRTA postdoctoral fellow at the National Institutes of Health, National Cancer Institute, Center for Cancer Research Nanobiology Program. She was promoted to tenured associate professor in 2013. Professor Yingling's research is focused on the development of advanced computational models and novel algorithms for multiscale molecular modeling of soft and biological materials and aims to provide a fundamental understanding of the structure-property relations of a variety of soft materials systems that are formed through the process of self-assembly. A University Faculty Scholar, she received a B.S. (University Diploma) in computer science and engineering from St. Petersburg State Polytechnic University, Russia and a Ph.D. in materials engineering from the Pennsylvania State University. Professor Yingling is a recipient of the NSF CAREER Award.

Linyou Cao

CAO joined the department in 2011 after serving as a Miller Research Fellow at the University of California, Berkeley with Paul Alivisatos. His group is working on two-dimensional (2D) materials, in particular, 2D transition metal dichalcogenide materials. The group is dedicated to bringing 2D materials into practical applications by focusing on the biggest challenges lying ahead. The research covers a broad range spanning controlled scalable synthesis, fundamental properties, and device development of 2D materials. The latest issues addressed by the group include understanding how the substrate may affect electronic, optical, thermal, and catalytic functionalities of 2D materials, understanding the true active sites and activating mechanism of MoS_2 for hydrogen evolution, and understanding the exciton dynamics in 2D materials under heavy excitation. Many of these research results bear significant potential for practical applications. Four new technical intellectual property disclosures have been filed and the group is working with the Office of Technology Commercialization and New Ventures to file provisional and full patents. One start-up, Atomic LLC, has also been spun off based on the technique developed by the group. Professor Cao received a Ph.D. in materials science and engineering at Stanford University. Professor Cao is a recipient of the NSF CAREER Award and a Young Investigator Program award from the Army Research Office.

James LeBeau

LEBEAU also joined the department in 2011 after finishing his Ph.D. in materials science and engineering at the University of California Santa Barbara. LeBeau's research group focuses on interfaces between dissimilar polar materials, relaxor ferroelectric materials, nitride lasers and light emitting diodes, approaches to connect local structure and chemistry with electron microscopy, and defects in new metal alloys. These projects develop and apply state-of-the-art electron microscopy methods to characterize material structure at a deep and fundamental level to understand properties. The work is highly collaborative in nature with materials created by partners located around the world. Professor LeBeau received his B.S. in materials science & engineering from Rensselaer Polytechnic Institute and his Ph.D. in materials from the University of California Santa Barbara. Professor LeBeau is a recipient of the NSF CAREER Award and a Young Investigator Program award from the Air Force Office of Scientific Research.

MSE undergraduate program continues to excel

Earlier this academic year, *US News & World Report* released its annual college rankings for undergraduate degree programs, and MSE at NC State currently ranks 16th among all MSE undergraduate programs in the country. Lending to the prestige and recognition of the undergraduate program is our ambition to stay small while getting big, says Dr. Cheryl Cass, MSE director of undergraduate programs. "In other words, in addition to growth in student enrollment, we have simultaneously improved the quality of our students as well as the high impact activities afforded to them."

Part of that impact in the summer of 2016 came from three notable international opportunities, which were initiated and supported by MSE faculty members, including: a National Science Foundation-funded International Research Experiences for Students (NSF IRES) led by Professor Jacob Jones, which provided support for students to conduct research in the area of energy storage and transduction in Sydney, Australia; an NSF IRES led by Professor Thom LaBean that supported student research projects in Aarhus, Denmark related to self-assembling DNA nanostructures; an introductory course (MSE 201) offered by Professor Cheryl Cass in a five-week study abroad experience in London, where students also visited the Royal Society and the Royal Academy of Engineering to learn about the history and influence of science and engineering in the UK and around the world.

These and other academic and professional development experiences facilitated by the MSE department have made our students very marketable in both industry and graduate school and have set them apart to achieve university and external awards and honors. Typically, about 25-30 percent of our students move on to graduate school, and our alumni can currently be found in doctoral programs at University of California Santa Barbara, Purdue University, Georgia Tech, University of Florida, Duke University and the Colorado School of Mines. Over the last three years, our students were hired into full-time positions at Fluor Corporation, Eastman Chemical Company, Lord Corporation, Deloitte, Navair, Boeing and Nucor Steel.

The MSE undergraduate program is also pleased to report that our six-year ABET accreditation review, which occurred in September, 2016, was extremely positive. In particular, the materials science and engineering program evaluator was impressed with our undergraduate laboratory courses and facilities, our industry-sponsored senior design program, the international opportunities afforded to our students and the outstanding MSE faculty committed to providing opportunities for research and dissemination.

The undergraduate program in the Department of Materials Science and Engineering currently supports 150 full-time students and awarded 36 bachelor's degrees during the 2015-16 academic year; both record highs for the department.

Graduate program grows, excels

Professor Elizabeth Dickey, director of the graduate program in MSE, answers questions about growth, student achievement and opportunities.

1. How large is MSE's graduate program now, and how does that compare to the size of the graduate program 10 years ago?

Ten years ago, we had just under 60 Ph.D. students in the department and we now have approximately 100, which is more than 65 percent growth. In addition, our M.S. program, which is predominantly through distance education, has grown from just a handful of students (seven in 2009) to about 35, a 500 percent increase.

2. Has there also been an increase in the quality of the students MSE is attracting? And how do you measure something like that?

While we have had very rapid growth in the size of our Ph.D. program, we have seen concomitant improvements in the credentials of our entering students. The most useful quantitative metric for evaluating "quality" is prior grade-point average (GPA). We have seen an upward trend in the undergraduate and prior graduate GPAs of our applicant pool and our enrolled students. Over the past three years, on average, our new graduate students have had an undergraduate GPA of 3.67.

3. What is MSE doing to better serve these students? What new initiatives are under way for grad students? *(see below)*

4. Can you tell me a little bit about any other new opportunities or internships for MSE grad students?

Our students have new opportunities for engagement in outreach programs in SciBridge, which is led by Professor Augustyn. We are also very excited to introduce a new NSF Research Traineeship (NRT) on Data-Enabled Science and Engineering of Atomic Structure, which is described elsewhere in the newsletter. An integral part of this program is a structured graduate internship after the students finish their preliminary exam.

Beyond the internship opportunities in the NRT program, we see growing opportunities for our graduate students to integrate an internship into their Ph.D. training. Currently, Brienne Johnson (Jones group) is interning at Boeing Corporation, Farshad Saberi (Brenner group) is at Cisco, and Min Fan (Schwartz & Koch groups) recently finished an internship with Hitachi Automotive. We are actively working with our industry and federal laboratory partners to identify unique internship opportunities for our students.

5. How have MSE's graduate students distinguished themselves in the past year?

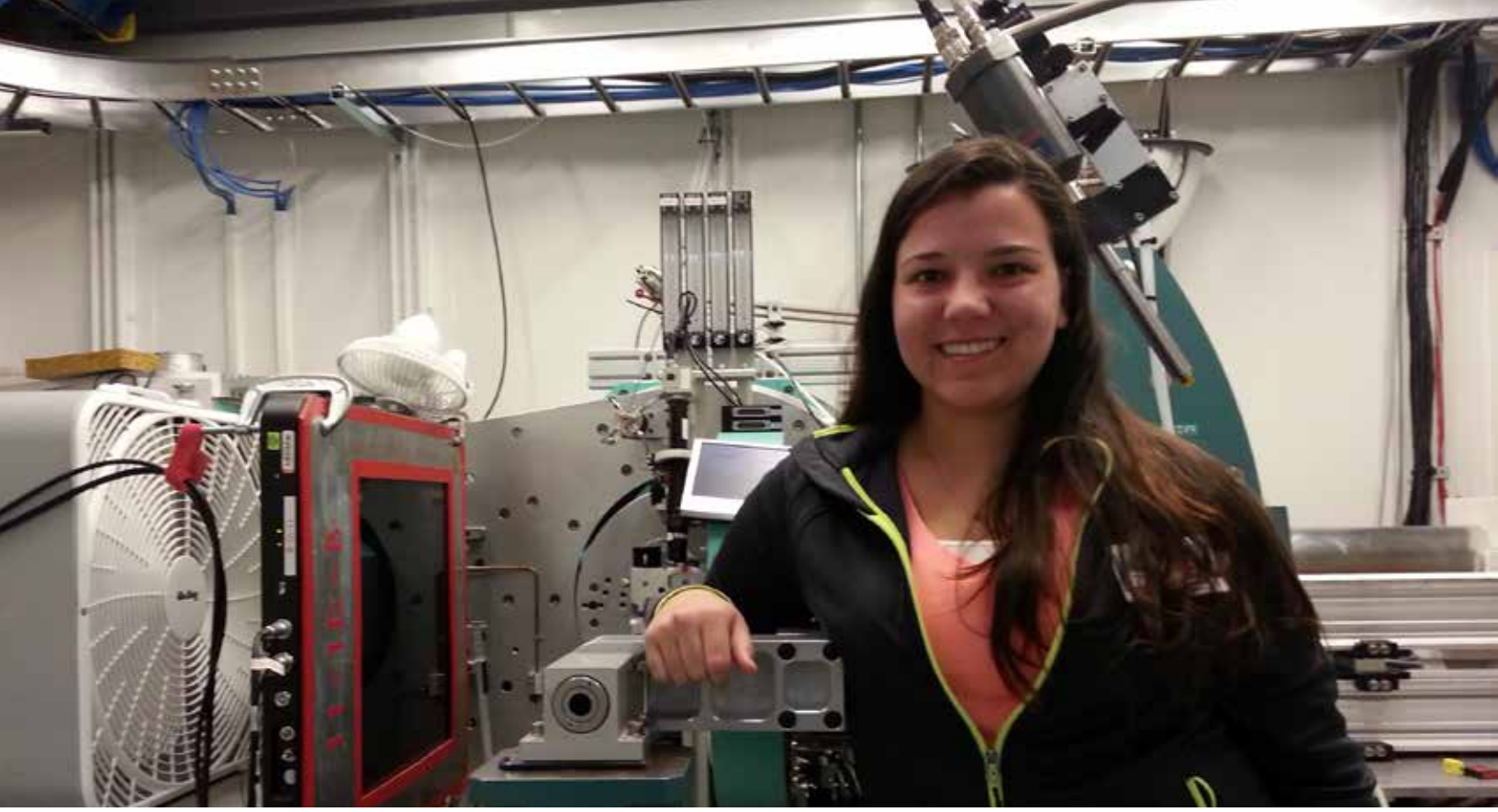
Our students continue to be recognized nationally for their academic and research accomplishments. Last year, we had three new NSF Graduate Research Fellowship awardees and a National Defense Science and Engineering Fellow. Currently, seven of our Ph.D. students hold these prestigious external fellowships. Our current students are also winning numerous awards from professional societies and at national and international professional meetings.

6. Has this growth of MSE's graduate program been reflected in the rankings or in other external assessments?

An annual ranking of graduate programs is performed by US News & World Report. Back in 2011, when I first arrived at NC State, we were ranked 30th. This year, we were ranked 15th in materials science and engineering graduate programs in the United States.

In addition, in Fall 2015, the entire graduate program was reviewed by a three-member review team comprised of Professor Chris Schuh, MSE department head at MIT, Professor Greg Rohrer, MSE department head at Carnegie-Mellon, and Professor Harald Ade from NC State's Department of Physics. The program received a very positive response, including a detailed report that opened with "The team was very favorably impressed with virtually every element of the program. Indeed, the strengths of the program are more than we can cover in detail." The review team provided valuable suggestions for further program enhancements which will be implemented in the coming year.

Brienne Johnson recently worked as an intern with Boeing.



Dr. Tedi-Marie Usher

Graduate student becomes research associate at national lab

Dr. Tedi-Marie Usher began her journey with Oak Ridge National Laboratory (ORNL) as a graduate student who was interested in materials science and engineering. Over the course of her graduate studies, Usher went to ORNL several times to conduct experiments that eventually led to her decision to take a position as a postdoctoral research associate there in April, 2016.

Located in Oak Ridge, Tenn., ORNL is the U.S. Department of Energy's largest research laboratory. Established in 1943 as part of the Manhattan Project, the laboratory now has two of the best neutron sources, the High Flux Isotope Reactor and the Spallation Neutron Source (SNS), which enable scientists to study the structures of materials and biological systems, areas where Usher has researched independently for her dissertation, "Local and Average Structures in Ferroelectrics under Perturbing Fields."

SNS is available to researchers worldwide with varying degrees of experience; a proposal of research must be submitted and reviewed by independent scientists and the most promising proposals are chosen to become experiments.

Usher was hired to work with SNS where she uses advanced methods to study the relationships between size, shape and surface molecules of nanocrystals of functional materials.

Usher became interested in materials science and engineering at the University of Florida, where she received a B.S. (2010); she continued her studies there for the next two years to receive her M.S. (2012), and recently graduated with her Ph.D. from NC State (2016). Usher said that she and other graduate students worked with Dr. Jacob L. Jones at the University of Florida, then chose to follow him to NC State when he relocated in 2013. Jones is now a professor in the Department of Materials Science and Engineering at NC State and is the director and principal investigator of the Research Triangle Nanotechnology Network. He is also the director of the Analytical Instrumentation Facility, and a University Faculty Scholar.

Usher's research interests are in crystallography, materials science, and X-ray/neutron scattering techniques. Some of her professors said that her research has made important advancements in how to measure structure-property relationships of solid-state materials.

She conducts experiments in which electric fields, elevated temperature, stress, or other stimuli are applied to the samples, which places the materials in conditions similar to those found in applications. In the future, Usher says she would like to figure out some of the fundamental aspects of the materials that she is working with and share those discoveries with other researchers.

ATI strengthens relationship with MSE

Allegheny Technologies Incorporated (ATI) has long had an important recruiting relationship with NC State MSE. Now that relationship will become even stronger with the Pittsburgh, Pa.-based company's selection of NC State as a partner school.

ATI, a leading producer of specialty materials and components, chose NC State as one of four partner schools with which to build a stronger relationship. That relationship will start with materials science and engineering but could expand to other areas of the university.

"Our value proposition with our customers resides with materials science, the science of producing materials that are appropriate for our markets and the customers we serve, so we wanted to start with that discipline," said Elizabeth Powers, ATI's senior vice president and chief human resources officer.

With annual revenues of approximately $3.1 billion, ATI produces titanium and nickel-based alloys, stainless and specialty steels and forgings and castings as well as powder products used in additive manufacturing applications. These products are used in the aerospace and defense, oil and gas, electrical energy, medical, automotive and construction markets, among others.

MSE has a close connection with ATI's Specialty Materials facilities in Monroe, NC, where the company manufactures advanced, often proprietary, titanium and nickel-based alloys for the aerospace and defense markets. The business has hosted more than 50 interns from NC State, many of who moved into full-time positions with the company.

ATI is an industry member of the Center for Additive Manufacturing and Logistics (CAMAL) based in NC State's Edward P. Fitts Department of Industrial and Systems Engineering, and several ATI employees have completed master's degrees in materials science and engineering through Engineering Online, the College of Engineering's distance education program. ATI and NC State's relationship has also resulted in ATI sponsoring several senior design projects in the College of Engineering.

"It was a natural fit," Powers said.

Justin Schwartz, MSE department head, said the relationship will provide a tremendous benefit for MSE students and faculty members with research experiences and career opportunities.

"We are excited to work with one of the world's leading companies bringing innovation in materials science to the marketplace," Schwartz said. "NC State's selection for this program is a terrific example of why the university is a great partner for business, and is also a reflection of our long-term commitment to metallurgy."

ATI representatives visited the MSE department in January and met with students and faculty members along with university staff who work in career development and on corporate partnerships.

The company has long had a presence at NC State's Engineering Career Fair, recruiting interns and full-time employees for the facility in Monroe. In September, ATI was there to recruit for other business units within the company, something that ATI says will continue.

As ATI's relationship with NC State continues to grow, it may move into other areas of the university. And while the new partnership began with recruiting, the plan is that it will expand into additional research areas. In addition to research projects that ATI has sponsored in the past through CAMAL, it could mean more research contracts coming to NC State for additional projects, said Melissa Martinez, ATI's vice president of new product development.

As part of the recruiting focus, ATI has created an Early Career Leadership Program for materials science engineers with a class of eight newly recruited graduates from partner schools. These employees will be exposed to work in several parts of the company, from engineering and research and development to the supply chain and commercial areas. The intent of the program is to develop well-rounded leaders.

Like many companies, ATI has identified a need to focus its recruiting effort on reliable sources of well-trained graduates who can become excellent employees.

"We're in the business of attracting, recruiting and retaining really good materials science talent," Powers said. "It's better for us if we do that really efficiently and effectively."

Department launches outreach event for African-American students

In 2012, MSE Department Head Dr. Justin Schwartz chaired a workshop aimed at making recommendations for enhancing diversity in materials science and engineering nationwide.

Dr. Frank Hunte, an assistant professor in MSE, was a member of the committee and co-organizer of one of the sessions. Though already aware of the prevailing lack of diversity in STEM fields, what he learned at this workshop surprised him.

"I was astonished at the statistics particularly for African Americans among the various underrepresented groups, in materials science and engineering in particular and STEM (science, technology, engineering and mathematics) in general," Hunte said. "On returning from that event, I felt compelled to try to come up with some solutions."

Hunte put together the first Eastman Chemical African American Family Science and Technology Day (AASTD), which was held on March 5 in the Duke Energy Hall in the James B. Hunt Jr. Library on NC State's Centennial Campus. African American students from the Triangle were invited, from K-12 students to current undergraduates who might be considering graduate school.

Hunte enlisted Roger Russell of SMILE Camp to help with demonstrations and reached out to several faculty members from NC State and from local historically black colleges and universities including North Carolina Central University, Saint Augustine's University, North Carolina A&T State University and Shaw University to talk to students about careers. Interactive demonstrations included fun with liquid nitrogen, plasma sources, crystal growth and demonstrations of non-Newtonian fluids. Brigadier General (Retired) Leodis T. Jennings, a 1983 NC State MSE graduate, served as the keynote speaker.

"Providing young African American students the opportunity to pursue degrees in STEM is critical," Jennings said. "My background in engineering provided the basis for me to understand technical and logistical aspects of the military (and life), and apply a deliberate and logical approach to problem solving. I am so proud of the MSE department for their outreach to the African-American community. It is important and will pay dividends to our country."

Eastman Chemical Company provided primary sponsorship of the event.

"At Eastman, we deeply value education and advancing STEAM education through strategic collaborations and programs," said Scott Armentrout, director of external innovation for Eastman. "An event such as this not only highlights education but also our commitment to diversity and inclusion, which fosters a culture that drives positive change and inspires innovation. It's more than philanthropy or doing the right thing. These commitments are part of who Eastman is."

In thinking about the barriers to entry for students from underrepresented groups in STEM fields and talking to others about the challenge, Hunte said he has come to believe that all students start out with similar goals and aspirations. But at some point along the way, some students encounter an experience that is discouraging to their aspirations.

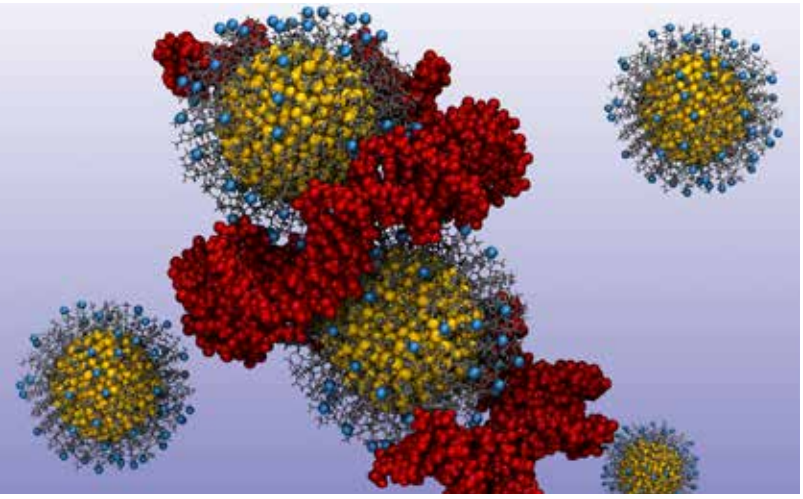
"Someone tells them that they can't or they shouldn't," Hunte said. "It has the effect of discouraging them from believing that they have the ability to be successful in STEM fields."

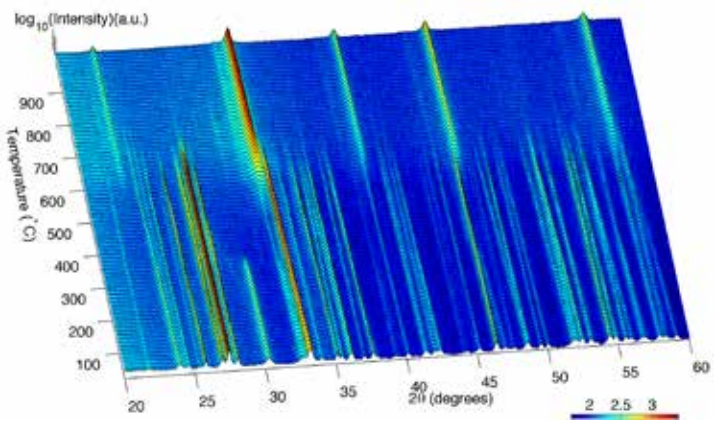
The second event is being planned for spring 2017 at James B. Jr. Hunt Library. Learn more at **www.mse.ncsu.edu/workshops/aafst**.

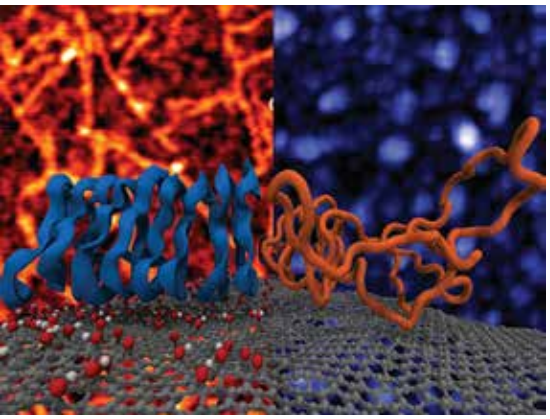
Contact Dr. Frank Hunte at 919.515.0276 or flhunte@ncsu.edu to learn how you can help.

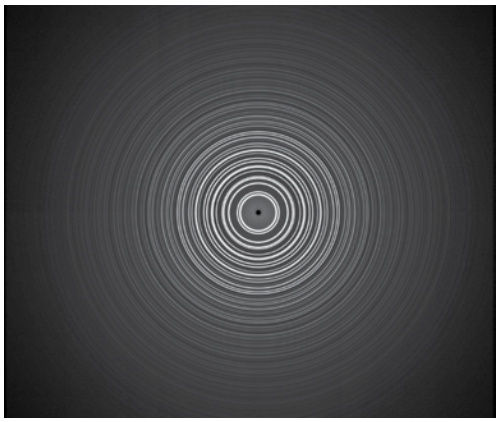
MATERIALS SCIENCE AND ENGINEERING AS ART

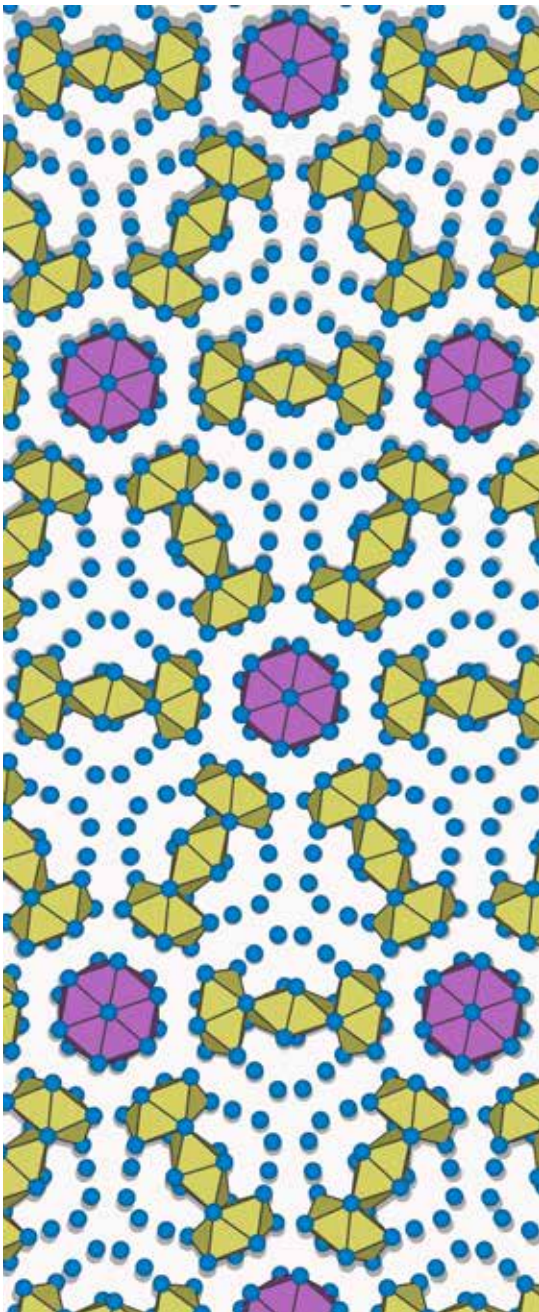
MSE students and faculty members produce some stunning research images. We have assembled some of this year's best below.

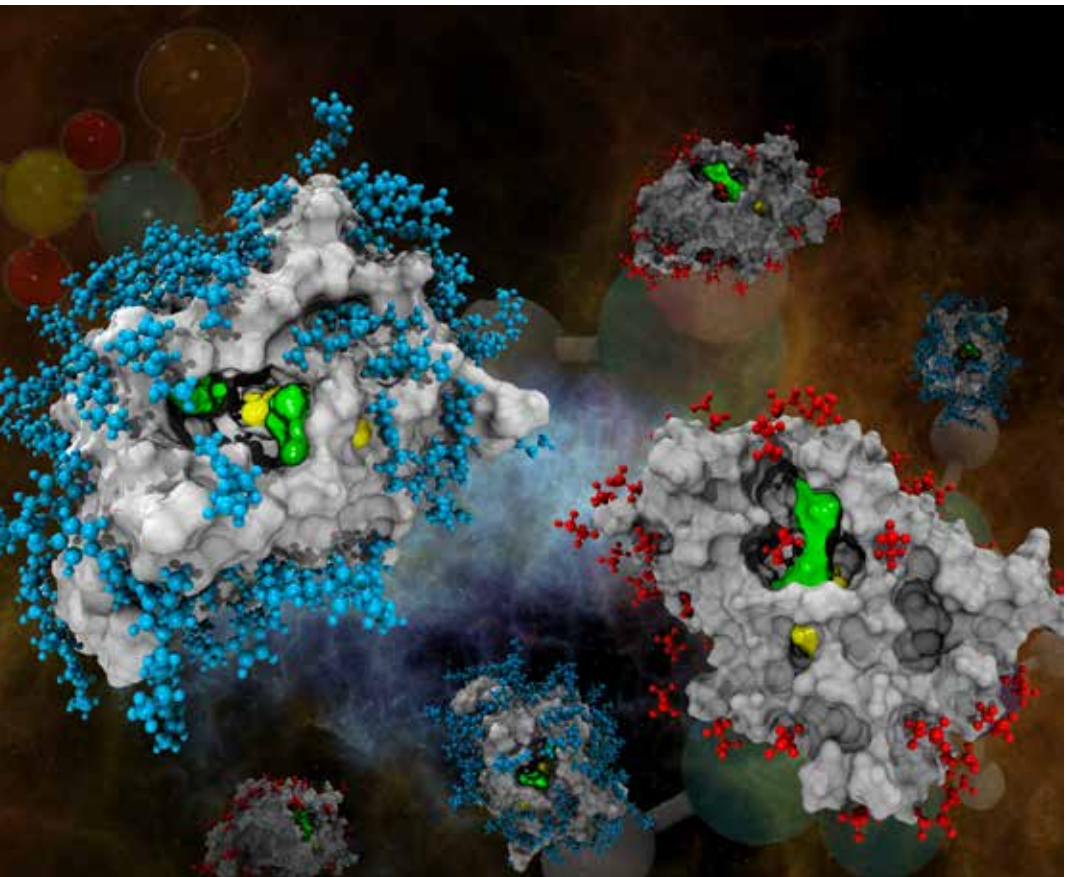












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Give Today. Impact Tomorrow.

The Department of Materials Science and Engineering (MSE) provides the highest quality education for future engineers and creates a research environment that drives innovation in North Carolina and beyond. The generosity of alumni and friends helps safeguard MSE's ability to extend educational opportunities to bright, deserving students and recruit and retain an outstanding faculty to teach these future scholars. Give Today. Impact Tomorrow.

MSE ENHANCEMENT FUND

Annual gifts to the MSE Enhancement Fund give current engineering students the same life-changing opportunities you enjoyed. These critical funds enable the department to address top priorities with the greatest flexibility. Resources from the MSE Enhancement Fund support an outstanding faculty, excellent students and significant teaching infrastructure. With your help and generosity, we can continue to respond immediately to emerging needs and exciting challenges and provide world-class educational experiences for all of our students. Make your gift today by visiting: **www.engr.ncsu.edu/giving**.

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- Graduate Fellowships - Endowed graduate fellowships provide essential support in the intense competition for graduate students, agents of innovation in the department.
- Distinguished Professorships - Endowed professorships are the most important vehicle for recruiting and retaining exceptional research faculty members, whose work in MSE solves significant challenges and improves the educational experience for all students. We also utilize the state of North Carolina's generous matching program, which underscores the importance of research faculty by providing 1/3 of the cost of an endowed professorship.

For more information on ways to support the MSE Department, please contact the NC State Engineering Foundation at 919.515.9958.

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